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NATIONAL DAM SAFETY PROGRAM. MILL DAM (NJ00540), DELAWARE RIVER--ETC(U)
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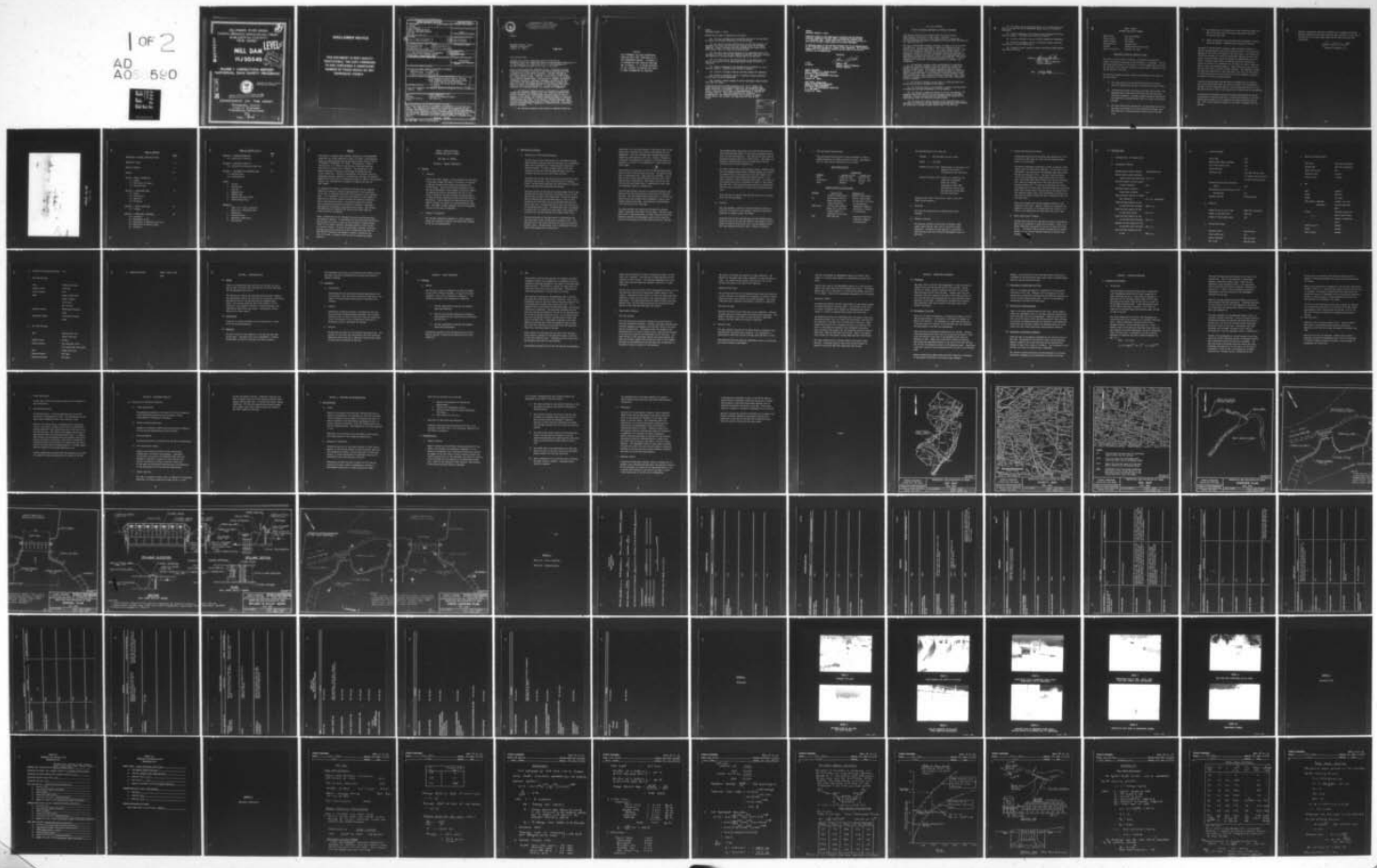

DELAWARE RIVER BASIN
NORTH BRANCH RANCOCAS CREEK,
BURLINGTON COUNTY
NEW JERSEY

MILL DAM
NJ00540

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY

Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

May, 1979

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Structural Analysis
Safety
Visual Inspection
National Dam Inspection Report
Mill Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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SECURITY CLASSIFICATION OF THIS PAGE (When Date Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

7 MAY 1979

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Mill Dam in Burlington County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Mill Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 21 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the fact that failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

b. The following remedial actions should be completed within six

months from the date of approval of this report:

(1) All trees and brush on the earthfill portions of the dam should be removed with minimal disturbance of the dam surface.

(2) The concrete spillway facilities at the Mill Dam Spillway, the abandoned power house and the Mill Race Spillway should be thoroughly inspected. Concrete surfaces should be sandblasted and coated with an epoxy sealant after all cracks are pressure grouted.

(3) The steel sheet piling installed on the downstream side of the dam should be cleaned of rust and remaining bituminous paint where possible and coated with a suitable durable sealant down to the mud line.

(4) The eroded area at the downstream end of the steel sheet pile wall on the east side of the downstream channel should be filled and stabilized.

(5) Debris accumulated in the spillway area and beneath the gates should be removed. Inoperable gates should be repaired.

(6) Initiate a program to monitor possible seepage and subsidence.

(7) Perform a topographic survey to establish present conditions for reference in future inspections.

(8) Initiate a formal program of annual inspections using standardized check-list forms.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Edwin B. Forsythe of the Sixth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

NAPEN-D
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N. J. Dept. of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

MILL DAM (NJ00540)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 18 December 1978 by Storch Engineers under contract to the State of New Jersey. The State, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Mill Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 21 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood). The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the fact that failure from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

b. The following remedial actions should be completed within six months from the date of approval of this report:

(1) All trees and brush on the earthfill portions of the dam should be removed with minimal disturbance of the dam surface.

(2) The concrete spillway facilities at the Mill Dam Spillway, the abandoned power house and the Mill Race Spillway should be thoroughly inspected. Concrete surfaces should be sandblasted and coated with an epoxy sealant after all cracks are pressure grouted.

(3) The steel sheet piling installed on the downstream side of the dam should be cleaned of rust and remaining bituminous paint where possible and coated with a suitable durable sealant down to the mud line.

(4) The eroded area at the downstream end of the steel sheet pile wall on the east side of the downstream channel should be filled and stabilized.

(5) Debris accumulated in the spillway area and beneath the gates should be removed. Inoperable gates should be repaired.

(6) Initiate a program to monitor possible seepage and subsidence.

(7) Perform a topographic survey to establish present conditions for reference in future inspections.

(8) Initiate a formal program of annual inspections using standardized check-list forms.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 7 May 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Mill Dam, NJ00540
State Located:	New Jersey
County Located:	Burlington
Drainage Basin:	Delaware River
Stream:	North Branch Rancocas Creek
Date of Inspection:	December 18, 1978

Assessment of General Condition of Dam

Mill Dam is in fair overall condition, and outwardly structurally stable. The hydraulic capacity of the spillways is inadequate. The SDF (Spillway Design Flood) for Mill Dam is 1/2 PMF (Probable Maximum Flood). The spillways at Mill Dam are capable of passing about 10 percent of the PMF (20 percent of the SDF).

The following remedial measures should be implemented by the owner in the near future.

1) All trees and brush on the earthfill portions of the dam should be removed with minimal disturbance of the dam surface.

2) The concrete spillway facilities at the Mill Dam Spillway, the abandoned power house and the Mill Race Spillway should be thoroughly inspected. Concrete surfaces should be sandblasted and coated with an epoxy sealant after all cracks are pressure grouted.

3) The steel sheet piling installed on the downstream side of the dam should be cleaned of rust and remaining bituminous paint and coated with a suitable durable sealant down to the mud line.

4) The eroded area at the downstream end of the steel sheet pile wall on the east side of the downstream channel should be filled and stabilized.

5) Debris accumulated in the spillway area and beneath the gates should be removed. Inoperable gates should be repaired.

The owner of the dam should initiate a formal program of annual inspection and maintenance with special attention given to the operational adequacy of the timber slide gates in the near future. The inspections should be performed by a qualified professional engineer and the observations and measurements should be recorded on standardized check-list forms. Inspection check-lists and complete records of maintenance should be included in a permanent file, available for public inspection. Repairs should be performed annually: remove brush and trees from the dam and clear debris from the spillway openings. The impoundment should be drawn down completely at least once every five years for the purpose of removing sediment at the spillway and to permit complete inspection and repair of the dam and appurtenances.

A qualified professional engineer should be engaged soon to perform a more sophisticated hydrologic and hydraulic analysis of the watershed, spillways and the downstream channel, and to design modifications to the dam and spillways so that a storm equivalent to the SDF can be accommodated.

A comprehensive topographic survey of the dam and appurtenances should be performed in the near future by a licensed land surveyor or qualified professional engineer soon to establish the present conditions at the dam. This survey should be included in the owner's permanent file for the dam.

Quarterly inspections should be initiated soon to observe and monitor possible seepage and subsidence along the dam, especially in the area of the dam west of the power house where the pervious riprap core was constructed.

Richard J. McDermott

Richard J. McDermott, P.E.

OVERVIEW - MILL DAM

18 Dec. 1978

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 30214. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

MILL DAM I.D. NJ00540

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

Mill Dam was inspected on December 8, 1978 to generally assess the structural integrity and operational adequacy of the dam and appurtenances.

1.2 Description of Project

a. Description of Dam and Appurtenances

The facilities at Mill Dam consist of a reinforced concrete gated spillway structure (Mill Dam Spillway) and an abandoned power house connected by an intervening earth area which extend east/west. A by-pass channel known as Mill Race continues to the west from the abandoned power house to a concrete spillway structure (Mill Race Spillway).

Discharge from the Mill Dam Spillway and from the Power House Spillway flows directly into the North Branch of Rancocas Creek. The Mill Race flow enters the North Branch of Rancocas Creek about 4000 feet downstream from the dam.

The earth portions of the dam are located between the Mill Dam Spillway and the power house and also extend east of the Mill Dam Spillway and west of the power house. The portion between the Mill Dam Spillway and the power house is flat at about elevation 10.6 feet (MSL) and is approximately 80 feet long and 55 feet wide. The upstream face of this area consists of an unprotected earth slope. The downstream side is bulkheaded for about half its length with steel sheet piling topped with a masonry wall and the remainder with timber sheet piling.

The earth area west of the power house is approximately 60 feet long with a crest 30 feet wide at elevation 10.6. The upstream side of the earth area along Mill Race is faced with grouted riprap. The downstream side is bulkheaded with steel sheet piling topped with a masonry wall.

Reportedly, this area was breached in 1972 and as part of the repair work a pervious rock core was incorporated into the embankment. There was no downstream flooding damage attributable to the breaching of Mill Dam. However, flooding of residential and commercial structures in the downstream area occurred as a result of the combination of storm runoff and tidal stage.

The portion of the dam east of the Mill Dam Spillway extends about 15 feet to the upstream creek bank. The upstream creek bank is stabilized with a steel sheet pile bulkhead. The 15 feet of bank between the bulkhead and the east side of Mill Dam Spillway is unprotected. Downstream from the Mill Dam Spillway the east channel bank is retained by a steel sheet pile bulkhead topped by a masonry wall.

The Mill Dam Spillway consists of a concrete foundation slab about 55 feet long with concrete training walls on the east and west. The area between the training walls is divided into seven sections by concrete piers connected on top by a continuous concrete deck beam. Each opening is approximately 7.25 feet wide and 15.4 feet high.

The seven openings are controlled with manually operated timber slide gates with timber lifting stems. The top of the gates forms a sharp-crested weir at about elevation 3.8 which naturally controls the impoundment water level by overflow. The top of the gates are 6.8 feet below the crest of the dam.

The abandoned power house west of the Mill Dam Spillway has three gated openings about 7.2 feet wide set between concrete piers and end training walls. This facility was once used to generate electrical power on a limited scale. These gates are presently inoperable and serve as an additional overflow spillway with its crest elevation 6.4.

Mill Race consists of a narrow by-pass channel, extending west from the abandoned power house. Discharge through this channel is controlled by a spillway with a total weir length of 20 feet consisting of two uncontrolled concrete weirs, 7 feet wide, flanking a timber slide gate 6 feet wide. The crests of the concrete weirs are at elevation 5.9 about 4.7 feet below the dam crest. The slide gate also serves as an overflow weir with its crest at elevation 5.6 about 5.0 feet below the dam crest.

The slide gate in the Mill Race Spillway serves as the outlet works for the impoundment.

b. Location

Mill Dam impounds a portion of the North Branch of Rancocas Creek and is located in the southeast section of Mount Holly Township, Burlington County, New Jersey.

Discharge from the Mill Dam Spillway and the abandoned power house spillway at Mill Dam and from Mill Race enters the North Branch of Rancocas Creek which flows into the Delaware River. The creek downstream from Mill Dam is tidally influenced.

c. Size and Hazard Classification

Size and Hazard Classification criteria presented in "Recommended Guidelines for Safety Inspection of Dams", published by the U.S. Army Corps of Engineers are as follows:

SIZE CLASSIFICATION

	Impoundment	
Category	Storage (Ac-ft)	Height (Ft)
Small	<1000 and ≥ 50	<40 and ≥ 25
Intermediate	≥ 1000 and $<50,000$	≥ 40 and <100
Large	$\geq 50,000$	≥ 100

HAZARD POTENTIAL CLASSIFICATION

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (no permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than few	Excessive (Extensive community, industry or agriculture)

W

The characteristics of Mill Dam are:

Storage = 927 acre-feet (at top of dam)

Height = 14.6 feet

Potential Loss of Life: Approximately 15 residential and commercial structures in the downstream SDF flood plain.

Potential Economic Loss: Flooding of residential and commercial development. Three road bridges downstream at 1500, 4000 and 4400 feet from the dam. One pedestrian bridge about 500 feet downstream.

Therefore, Mill Dam is classified as "Small" size with "High" hazard potential.

d. Ownership

Mill Dam and appurtenances are owned by Mount Holly Township.

e. Purpose of the Dam

Mill Dam was originally constructed to impound a water supply source and was later used for electrical power generation. Presently the dam impounds a recreational pond with park area and residential development along its shoreline.

f. Design and Construction History

Information pertaining to the design and construction of the facilities at Mill Dam, Mill Race and the abandoned power house is not available.

The dam was reportedly constructed in 1845 to impound a water supply source for Mount Holly Township. In 1973 repairs were performed in the area west of the abandoned power house after the dam was breached in 1972. The repair work consisted: filling the breached area; constructing a pervious riprap core; installing steel sheet piling at the toe of the masonry wall along the downstream side of the dam; pointing the existing masonry wall; filling the intervening area between the masonry wall and the sheet piling with concrete; installing steel sheet piling returns from the ends of the masonry walls and replacing timber piles, wales and hardware (including tie rod from turn buckle) between the end of the masonry wall and the power house.

There was no downstream flooding damage attributal to the breaching of Mill Dam. However, flooding of residential and commercial structures in the downstream area did occur as a result of the combination of storm runoff and tidal stage.

g. Normal Operational Procedure

The gate facilities at Mill Dam and Mill Race are operated by public works personnel of Mount Holly Township. There is no formal operational procedure for the use of these facilities. The gates in the Mill Dam Spillway are opened during intense storms so as to relieve upstream flooding and prevent overtopping of the dam.

1.3 Pertinent Data

a. Drainage Area - 144 square miles

b. Discharge at Damsite

Maximum known flood at damsite	Dam breached 1972
Outlet works at pool elevation (Gate at Mill Race Spillway)	78 c.f.s.
Diversion tunnel low pool outlet at pool elevation	N.A.
Diversion tunnel outlet at normal pool elevation	N.A.
Gated spillway capacity at normal pool elevation	14 c.f.s. (Estimated)
Gated spillway capacity at top of dam (Mill Dam Spillway)	1684 c.f.s.
Gated Spillway capacity at top of dam (Power House)	270 c.f.s.
Gated spillway capacity at top of dam (Mill Race Spillway)	148 c.f.s.
Ungated spillway capacity at top of dam (Mill Race Spillway)	564 c.f.s.
Total spillway capacity at top of dam	2666 c.f.s.

c. Elevation (NGVD)

Top of Dam	10.6
Maximum pool-design surcharge	12.9
Full flood control pool	N.A.
Recreation pool	4.0
Spillway crest	3.8 (Mill Dam Spillway)
	6.4 (Power House Spillway)
	5.6 (Mill Race Spillway)
Upstream portal invert diversion tunnel	N.A.
Downstream bed at centerline of Mill Dam Spillway	-4.0
Maximum tailwater	12.9(Estimated)

d. Reservoir

Length of pool at top of dam	3500 feet (Estimated)
Length of recreation pool	3000 feet
Length of flood control pool	N.A.

e. Storage (Acre-feet)

Recreation pool	102 acre-feet
Flood control pool	N.A.
Design surcharge	851 acre-feet
Top of dam	566 acre-feet

f. Reservoir Surface (Acres)

Top of dam	131 acres (estimated)
Maximum pool	165 acres (estimated)
Flood control pool	N.A.
Recreation pool	37 acres
Spillway crest	37 acres

g. Dam

Type	Earthfill
Length	240 feet
Height	14.6 feet
Side slopes - Upstream	1 horiz. to 1 vert.
Downstream	Vertical Retaining Walls
Zoning	Pervious riprap core west of power house. Unknown in remaining areas.
Impervious core	Unknown
Cutoff	Unknown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Mill Dam Spillway

Type	Timber-Slide Gates
Length of weir	50.8 feet
Crest elevation	93.8
Gates	Manual Timber Slide Gates (7 gates) 7.25' wide by 7.8' high
Upstream channel	North Branch Roncocas Creek
Downstream channel	North Branch Roncoas Creek

j. Mill Race Spillway

Type	Concrete Weirs and Timber Slide Gate
Length of weir	20 feet
Crest elevation	95.9 feet(Conc. Weir) 95.6 feet(Timber Slide Gate)
Gate	Timber Slide Gate
Upstream Channel	Mill Race
Downstream Channel	Mill Race

k.	Regulating Outlets	Manual Timber Slide Gate

SECTION 2: ENGINEERING DATA

2.1 Design

There is no engineering data available for the dam, nor any of the spillway structures (Mill Dam Spillway, Mill Race Spillway, and the abandoned power house).

One construction drawing was obtained from Mount Holly Township for improvements made to the retaining wall structures immediately downstream from Mill Dam Spillway and the abandoned power house. This drawing dated May 1973 titled "Repairs to Mill Dam Walls", was prepared by Richard A. Alaimo Associates, 200 High Street, Mount Holly, New Jersey. Calculations are not available for these repairs.

2.2 Construction

There are no records available for the construction or repair of the dam and appurtenances.

2.3 Operation

No formal records of the operation of the dam have been kept by the owner. The water level in the impoundment is lowered periodically to clean the spillways and remove sediment.

The impoundment water level is monitored during intense storms by municipal officials and employees and the gates are opened to increase discharge.

2.4 Evaluation

a. Availability

Engineering data for the original dam and appurtenances are not available. One construction drawing was obtained for the repair of the downstream retaining walls from Mount Holly Township.

b. Adequacy

Essentially no engineering data is available for Mill Dam. The construction drawing obtained from Mount Holly Township pertains solely to repair of the walls along the downstream side of the dam and is not of significant assistance in performing a Phase I assessment for the dam.

c. Validity

No data were available for the original dam construction. The drawing for the repair work performed on the walls along the downstream side of the dam is generally accurate with respect to the as-built conditions at the site.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

Mill Dam was inspected on December 18, 1978, by members of the staff of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for inspection:

1. The dam, appurtenant structures and adjacent areas were examined.

2. The dam and accessible appurtenant structures were measured and key elevations were determined by hand level.

3. The dam, appurtenant structures and adjacent areas were photographed.

Information presented in the following portions of this Section consists of observations made during the field inspection.

b. Dam

The earthfill areas of Mill Dam have an irregular horizontal alignment, however the alignment was in conformance with the construction drawing prepared for the repair of the downstream retaining walls. The earthfill surfaces in these areas were level with thick grass cover and some trees. There were no localized depressions or visible signs of distress.

The retaining structures on the downstream side of the dam were generally plumb with no signs of distress. Most of the bituminuous paint on the steel sheet piling had peeled off and the exposed steel surfaces were coated with rust. It is apparent that as constructed the dam would exhibit considerable resistance to breaching. The land areas extending east and west from the dam are generally flat and at the same elevation as the top of the dam (elevation 10.6). It is estimated that the total overtopping length of the dam would be about 1000 feet at elevation 10.6. Overtopping discharge in the areas adjacent to the dam would flow over expansive gently sloped park land (Mill Dam Park and Iron Works Park) and eventually rejoin the creek downstream of the dam.

Minor erosion was observed along the east side of the downstream channel, adjacent to the downstream return at the end of the steel sheet pile wall. Apparently surface runoff from the adjacent area drains at this location

The embankment between the Mill Dam Spillway and the abandoned

power house consisted of a natural earthslope at about 1.5 horizontal to 1 vertical. This area was in good condition with no erosion or animal burrows. The upstream embankment west of the power house has been faced with grouted riprap and is in good condition.

Surface soils in the vicinity of Mill Dam generally consist of silt and sand with some clay and significant organic matter on the surface. Underlying strata consist of silty and clayey sand interbedded with sandy clay; and sand, silty sand and sandy silt with some gravel. The underlying strata are known as Mount Laurel and Wenonah Sands, and were deposited during the Cretaceous Period. Bedrock is more than 100 feet below the surface.

c. Appurtenant Structures

Mill Dam Spillway

Mill Dam Spillway was generally structurally sound with no no ticeable differential movement. Numerous areas were observed where concrete aggregate are exposed on the vertical faces of the piers and the training walls. Reinforcing steel was exposed at the downstream heels of several concrete piers. Spalling has occurred at construction joints on the downstream face of the piers. The upper surface of the continuous concrete deck beam spanning the piers was spalled, however the reinforcing steel was not exposed. The edges on the underside of the deck beam were cracked away at the apex of arches at several of the openings.

The timber slide gates were generally in poor condition. The majority of the gates were either inoperable or very difficult to raise. The second and third gates from the east side of the spillway were open at the time of the inspection.

Abandoned Power House

The spillway facilities at the abandoned power house were generally in poor condition, but appeared to be outwardly structurally sound. Concrete surfaces were typified by exposed aggregate. The timber slide gates were inoperable and closed at the time of inspection.

Mill Race Spillway

Spillway facilities on Mill Race were in fair condition. Concrete surfaces exposed to flowing water exhibited exposed aggregate. The timber slide gate at the center of the spillway is reportedly operable, but was closed at the time of inspection.

d. Reservoir Area

Mill Dam impounds a portion of the North Branch of Rancocas Creek extending east from Mount Holly Township. The impoundment is approximately 3000 feet long and averages about 200 feet in width.

The immediate shoreline along the impoundment consists of municipal parks and residential development.

The area surrounding the impoundment slopes up at about 3 horizontal to 1 vertical and steeper to a broad gently sloping flood plain.

The Mill Race area of the impoundment consists of a narrow by-pass channel that leads west from the abandoned power house. The channel banks slope up at 3 horizontal to 1 vertical and steeper along most of its length. There was no noticeable sedimentation of the channel.

c. Downstream Channel

The downstream channel from Mill Dam consists of the natural channel of the North Branch of Rancocas Creek. This portion of the creek is tidally influenced and is subject to flooding during intense storms as a result of combined storm runoff and tidal stage.

The downstream channel has steep banks that rise about 2 feet above the observed water level to a broad flat flood plain, consisting of Mill Dam Park to the West and Iron Works Park to the east. Downstream from the parks for a distance of about 1.5 miles the flood plain is developed with commercial and residential structures. There are three road bridges over the downstream channel located at about 1500, 4000 and 4500 feet from the dam. There is one pedestrian bridge over the channel located about 500 feet from the dam.

Mill Race extends west as a narrow channel from the Mill Race Spillway. Discharge from Mill Race joins the North Branch of Rancocas Creek about 4000 feet downstream from the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The water level in the Mill Dam impoundment is normally naturally controlled by overflow through the Mill Dam Spillway. During periods of intense rainfall discharge also occurs at the Power House Spillway and Mill Race Spillway. Intense storm flows are reportedly passed by opening slide gates at Mill Dam Spillway and Mill Race Spillway and evacuating the low lying downstream areas. Operation of the gates is performed by the Mount Holly Township Road Department under the direction of the Mount Holly Civil Defense Coordinator.

4.2 Maintenance of the Dam

There are no regular maintenance or inspection procedures for Mill Dam and appurtenances. Maintenance is performed "as-needed" by Mount Holly Township. The impoundment is drawn down periodically to permit removal of sediment in the upstream area, and inspection and maintenance of the dam and appurtenances.

There has been no maintenance documentation for the dam. The most recent maintenance and repair work at the dam was performed in 1973 after the earthfill area west of the abandoned power house was breached in 1972. Repair work consisted of repairing retaining walls along the downstream channel in the area of Mill Dam Spillway and filling the breached area west of the abandoned power. Reportedly, a pervious riprap core was constructed within the dam in the breached area.

Based on observations made during the field inspection, maintenance of the earthfill portions of the dam has been adequate.

However, the spillway facilities have been poorly maintained as evidenced by spalled concrete areas, major areas of exposed aggregate and exposed reinforcing steel.

4.3 Maintenance of Operating Facilities

There is no regular maintenance or inspection of the operating facilities at Mill Dam. Generally the slide gates are in poor condition as evidenced by inoperability and difficult operation at all but the Mill Race Spillway gate. There is no maintenance documentation available for these gates.

4.4 Description of Warning System

There is no formal warning system for Mill Dam. During intense storms the impoundment level is reportedly observed frequently by local municipal officials and employees. Based on these observations the slide gates at Mill Dam Spillway and Mill Race Spillway are adjusted to augment discharge and residents in the downstream flood plain are evacuated, because the combined effects of storm runoff and tidal stage occasionally cause excessive flooding.

4.5 Evaluation of Operational Adequacy

There has been no maintenance documentation for the facilities at Mill Dam. Maintenance of the earthfill areas has been adequate, however, operating facilities have been poorly maintained and allowed to lapse into a state of disrepair. The slide gates on the spillway facilities are operationally inadequate.

The informal warning system that has been developed is seriously hindered by inadequacy of the operating facilities at the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

Size and hazard classification were used in conjunction with "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers to establish the SDF (Spillway Design Flood) for Mill Dam. The appropriate design range for this dam is 1/2 PMF to PMF (Probable Maximum Flood). Since the characteristics of Mill Dam as described in Section 1, fall into the lower end of the prescribed classification range, 1/2 PMF is used as the SDF.

The inflow hydrograph for the Mill Dam impoundment was calculated using Clark's Method with a synthetic time-area curve. General hydrologic characteristics such as: Drainage Area(DA), Surface Storage Index (S_t), Main Channel Slope (S) and Man-made Impervious Cover Index (I) were computed using USGS quadrangles and aerial photographs. These data were used in conjunction with the following equations to determine the Clark's Method Parameters (R and T_c):

$$R/T_c + R = 0.76$$

$$T_c + R = (DA/S)^{0.22} \quad (S_t)^{0.33} \quad (1 + 0.3I)^{-0.28}$$

The total drainage area contributing to Mill Dam is 144 square miles. Most of the watershed is undeveloped woodland, swamp and cranberry bogs. There are four moderately sized population centers in the watershed: Fort Dix Military Reservation, Pemberton, Vincetown and Browns Mills. There is also considerable residential development along the shoreline of the impoundment, upstream from the dam.

Reservoir storage capacities were estimated using surface areas measured from USGS quadrangles. Discharge hydraulics for the spillway facilities were computed by considering the slide gates and concrete weir sections as sharp-crested weirs (See Appendix 4).

The tidal influence of the downstream channel results in variable tailwater conditions. Since the largest hydraulic differential between the upstream and downstream sides of the dam occurs at low tide, the most serious downstream hazard will exist at low tide. Accordingly, the stage discharge with tailwater influence for Mill Dam was evaluated for a low tide condition, which is conservative.

The SDF inflow hydrograph was routed through the spillway facilities at Mill Dam using the HEC-1-DB Computer Program which indicated that the dam would be overtopped. The HEC-1-DB analysis performed accurately models the stage discharge characteristics for the dam up to the point of overtopping. Once the dam is overtopped the tailwater elevation will increase rapidly, inundating the dam.

At the start of overtopping there would be about one foot of hydraulic differential between the upstream and downstream sides of the dam.

Based on the calculations in Appendix 4, the SDF peak inflow would be about 14,055 c.f.s. and would occur about 15 hours after the dam is inundated. Discharge and downstream flood stage during the period when the dam is submerged can not be accurately determined without a complete analyses of the downstream flood plain and consideration of the changing tidal stage.

It also was calculated that the existing spillways are adequate for a maximum flow equivalent to 10 percent of the PMF without overtopping the dam. Since the SDF for the dam is 1/2 of the PMF, the spillways are adequate to accommodate 20 percent of the SDF.

b. Experience Data

Reportedly, Mill Dam was breached in 1972. The area immediately west of the abandoned power house was washed out. Reportedly, Mill Dam has not been overtopped or breached since 1972.

Municipal officials and employees in Mount Holly Township reportedly observe the impoundment water level during periods of intense rainfall and adjust the gates in the spillways to accommodate the storm flows.

c. Visual Observation

At the time of the field inspection there was no evidence of past overtopping.

d. Overtopping Potential

As indicated above, a storm of magnitude equal to the SDF would cause overtopping of the dam. Once overtopped, the dam would become submerged within a short period of time.

Based on field observations, overtopping at Mill Dam would occur in the area of the dam, as well as for a considerable distance along Mill Race channel banks and to the east of the Mill Dam Spillway. The effective overtopped length would be approximately 1000 feet including channel banks. It appears that the dam, and surrounding berms and bulkhead areas would provide resistance to breaching. When this is considered in combination with the small hydraulic differential that would exist at the point when overtopping begins, it further appears that the probability of the dam breaching is low.

Further computations indicated that the spillways at Mill Dam are capable of passing approximately 10 percent of the PMF.

40

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The embankment appeared, at the time of the field inspection, to be structurally stable with no evidence of cracks, displacement or differential settlement.

b. Design and Construction Data

Analyses of structural stability and construction information for the dam and appurtenances are not available.

c. Operating Records

No operating records are available for the dam or appurtenances.

d. Post Construction Changes

There are no records available for post construction changes made to the dam or appurtenances. Reportedly, the earthfill area west of the abandoned power house was breached in 1972 and in repairing it the original cross section was altered to include a pervious riprap core. At the same time the masonry retaining walls and bulkheading on the downstream side of the dam were reconstructed.

e. Seismic Stability

Mill Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams" which is a zone

of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions, if stable under static loading conditions. Mill Dam and appurtenances outwardly appear to be stable under static loading conditions, based on the field inspection performed.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on the hydraulic and hydrologic analyses described in Section 5 and Appendix 4 the spillways at Mill Dam are hydraulically inadequate and are capable of passing flows equal to about 10 percent of the PMF without overtopping the dam. A storm of magnitude equivalent to the SDF (1/2PMF) would overtop and inundate the dam. The probability of the dam breaching is low.

Outwardly, the facilities at Mill Dam appear to be structurally stable based on field inspection observations.

b. Adequacy of Information

Information sources for this study include: 1) field investigations, 2) Plan titled "Repairs to Mill Dam Walls" dated May 1973 prepared by Richard A. Alaimo Associates, 3) USGS quadrangles, 4) aerial photographs for Burlington County and 5) consultation with local municipal officials.

Information available and data collected for Mill Dam are sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some data not available are as follows:

1. Records of maintenance for the dam and appurtenances.
2. Typical earth embankment sections.
3. Structural and hydraulic design computations and reports.
4. Soils report for the site.

c. Necessity for Additional Data/Evaluation

Although engineering data pertaining to Mill Dam is not available, additional data is not considered imperative for this Phase I evaluation.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses performed for this report, the spillways are assessed as inadequate. It is therefore recommended, that a qualified professional engineer be engaged in the near future to more accurately analyze the runoff characteristics of the watershed, the hydraulic capacity of the spillways and the capacity of the downstream channel area. Based on the findings of these analyses, modifications to the dam and spillway should be designed.

It is further recommended that the following measures be undertaken by the owner in the near future.

1) All trees and brush on the earthfill portions of the dam should be removed with minimal disturbance of the dam surface.

2) The concrete spillway facilities at the Mill Dam Spillway, the abandoned power house and the Mill Race Spillway should be thoroughly inspected. Concrete surfaces should be sanblasted and coated with an epoxy sealant after all cracks are pressure grouted.

3) The steel sheet piling installed on the downstream side of the dam should be cleaned of rust and remaining bituminous paint where possible and coated with a suitable durable sealant down to the mud line.

4) The eroded area at the downstream end of the steel sheet pile wall on the east side of the downstream channel should be filled and stabilized.

5) Debris accumulated in the spillway area and beneath the gates should be removed. Inoperable gates should be repaired.

The implementation of the above measures will require proper detailed design and that applicable NJDEP approvals be obtained.

b. Maintenance

The owner of the dam should initiate a formal program of annual inspection and maintenance with special attention given to the operational adequacy of the timber slide gates in the near future. The inspections should be performed by a qualified professional engineer and the observations and measurements should be recorded on standardized check-list forms. Inspection check-lists and complete records of maintenance should be included in a permanent file, available for public inspection. Repairs should be performed as required and the following maintenance should be performed annually: remove brush and trees from the dam and clear debris from the spillway openings. The impoundment should be drawn down completely at least once every five years for the purpose of removing sediment at the spillway and to permit complete inspection and repair of the dam and appurtenances.

c. Additonal Studies

A qualified professional engineer should be engaged soon to perform a more sophisticated hydrologic and hydraulic analysis of the watershed, spillways and the downstream channel, and to design modifications to the dam and spillways so that a storm equivalent to the SDF can be accommodated.

A comprehensive topographic survey of the dam and appurtenances should be performed in the near future by a licensed land surveyor or qualified professional engineer soon to establish the present conditions at the dam. This survey should be included in the owner's permanent file for the dam.

Quarterly inspections should be initiated soon to observe and monitor posssible seepage and subsidence along the dam, especially in the area of the dam west of the power house where the pervious riprap core was constructed.

PLATES

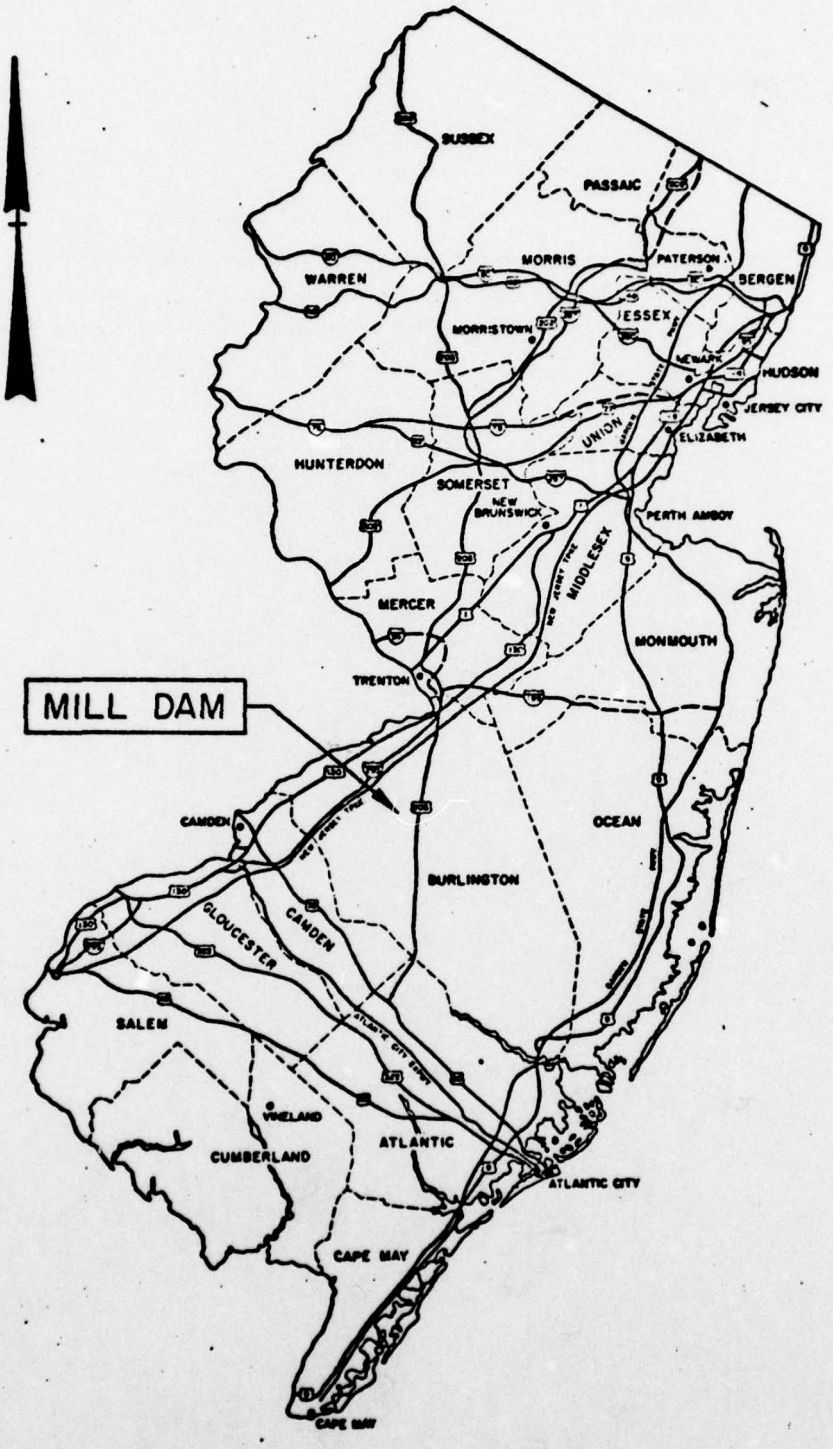


PLATE 1

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

KEY MAP

MILL DAM

I.D. N.J. 00540

SCALE: NONE

DATE: MARCH, 1979

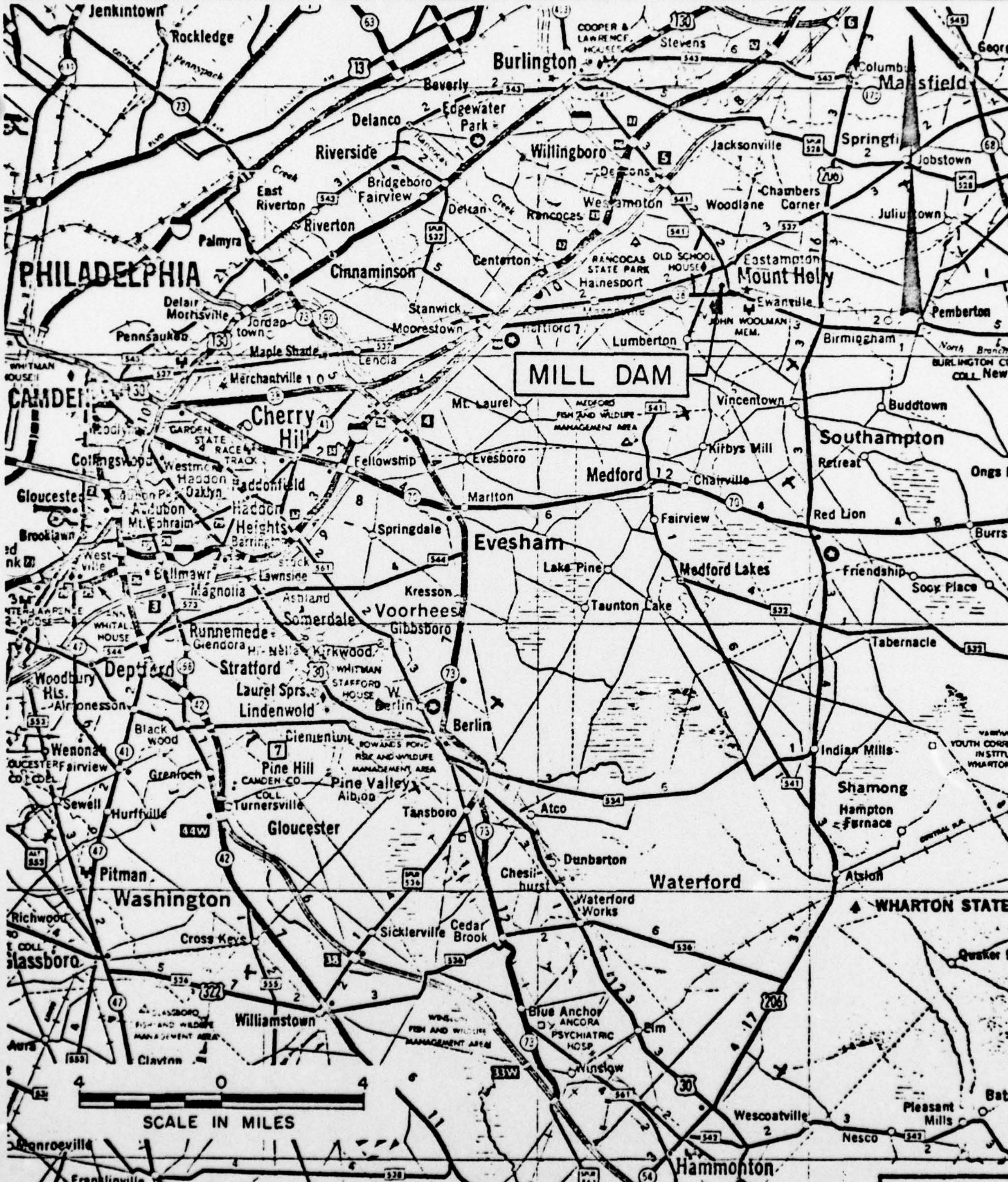
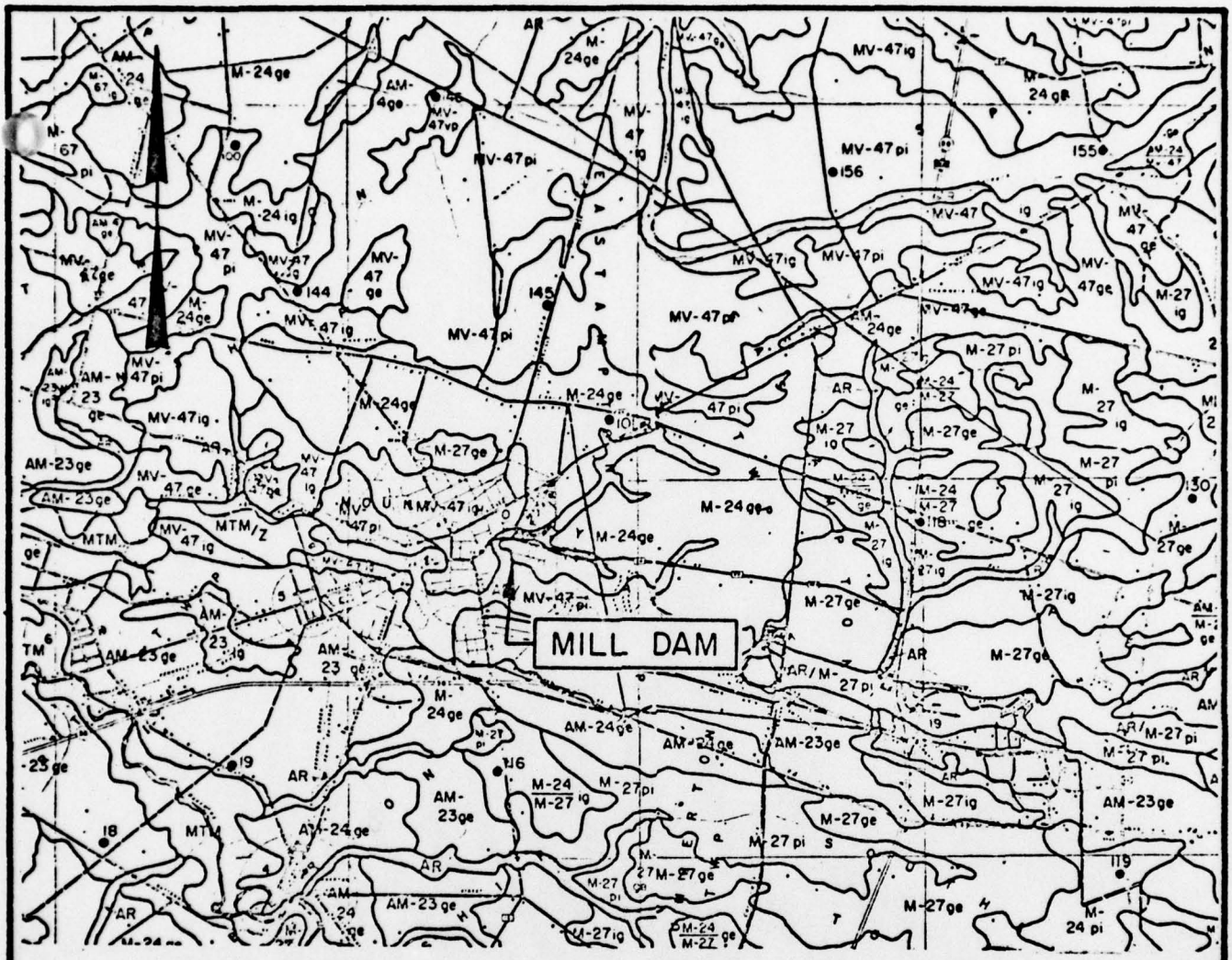


PLATE 2

STORCH ENGINEERS **FLORHAM PARK, NEW JERSEY**	**INSPECTION AND EVALUATION OF DAMS** **VICINITY MAP** **MILL DAM**
DIVISION OF WATER RESOURCES **N.J. DEPT. OF ENVIR. PROTECTION** **TRENTON, NEW JERSEY**	I.D. N.J. 00540 — SCALE: AS SHOWN DATE: MARCH, 1979



Legend

AR	Silt and sand with some clay and significant organic matter near the surface.
MV-47	Silty and clayey sand interbedded with sandy clay (Mount Laurel and Wenonah Sand).
M-24	Sand, silty sand and sandy silt with some gravel (Mount Laurel and Wenonah Sands).

Note Information taken from Rutgers University Soil Survey of New Jersey, Report No. 20, Burlington County and Geologic Map of New Jersey prepared by Lewis and Kummel.

PLATE 3

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

SOIL MAP

MILL DAM

I.D. N.J. 00540

SCALE: NONE

DATE: MARCH, 1979

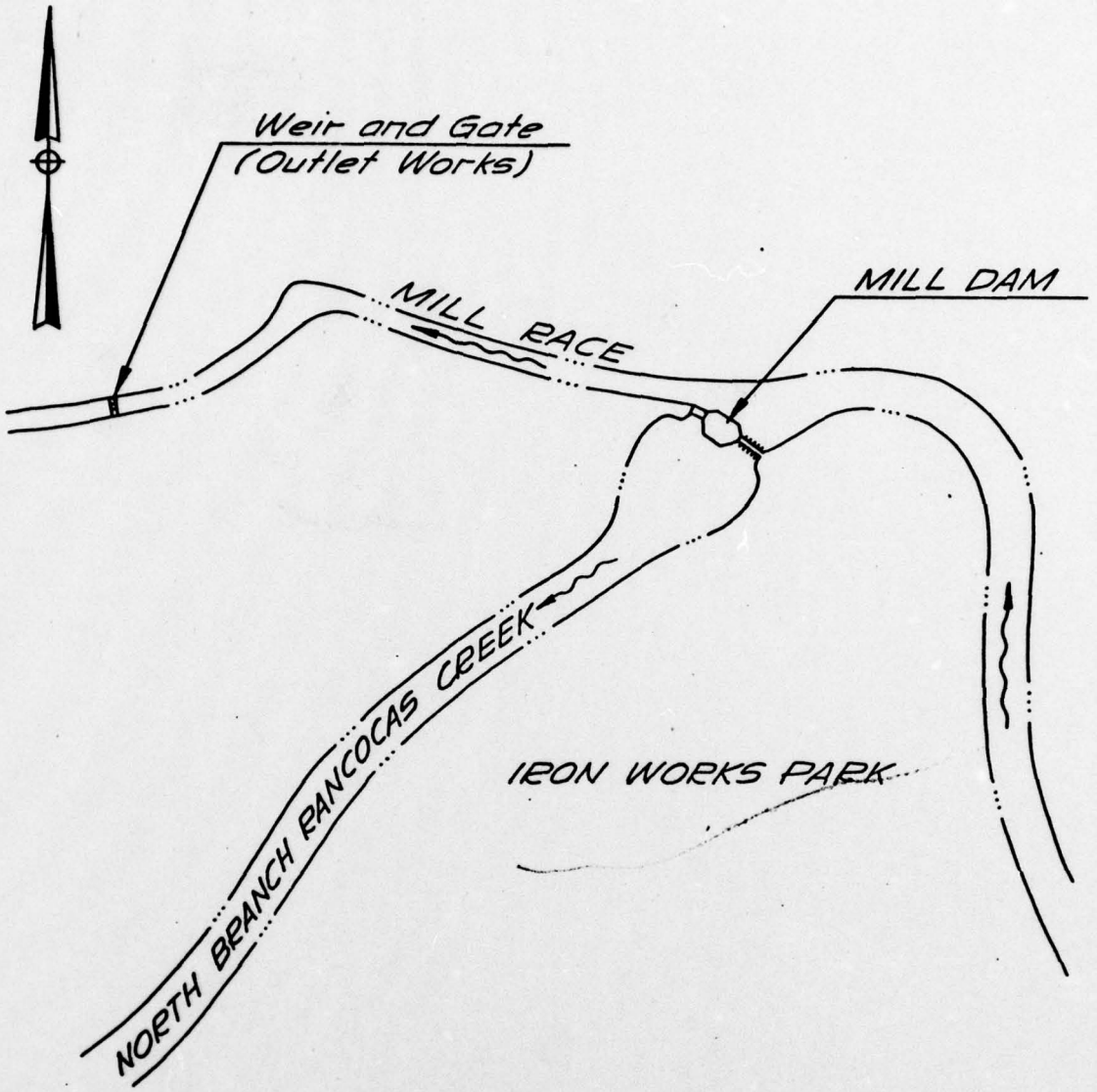


PLATE 4

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

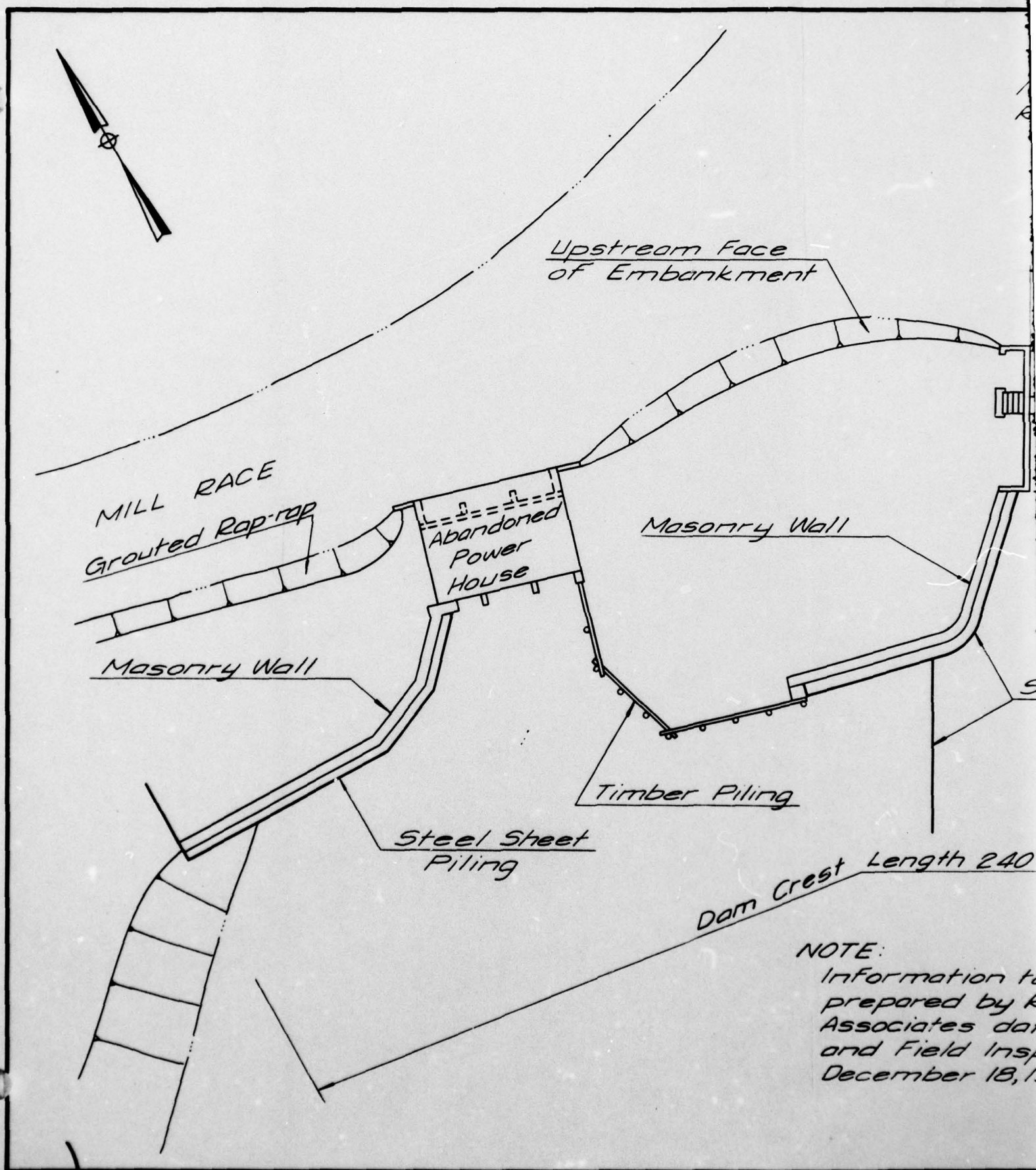
OVERVIEW PLAN

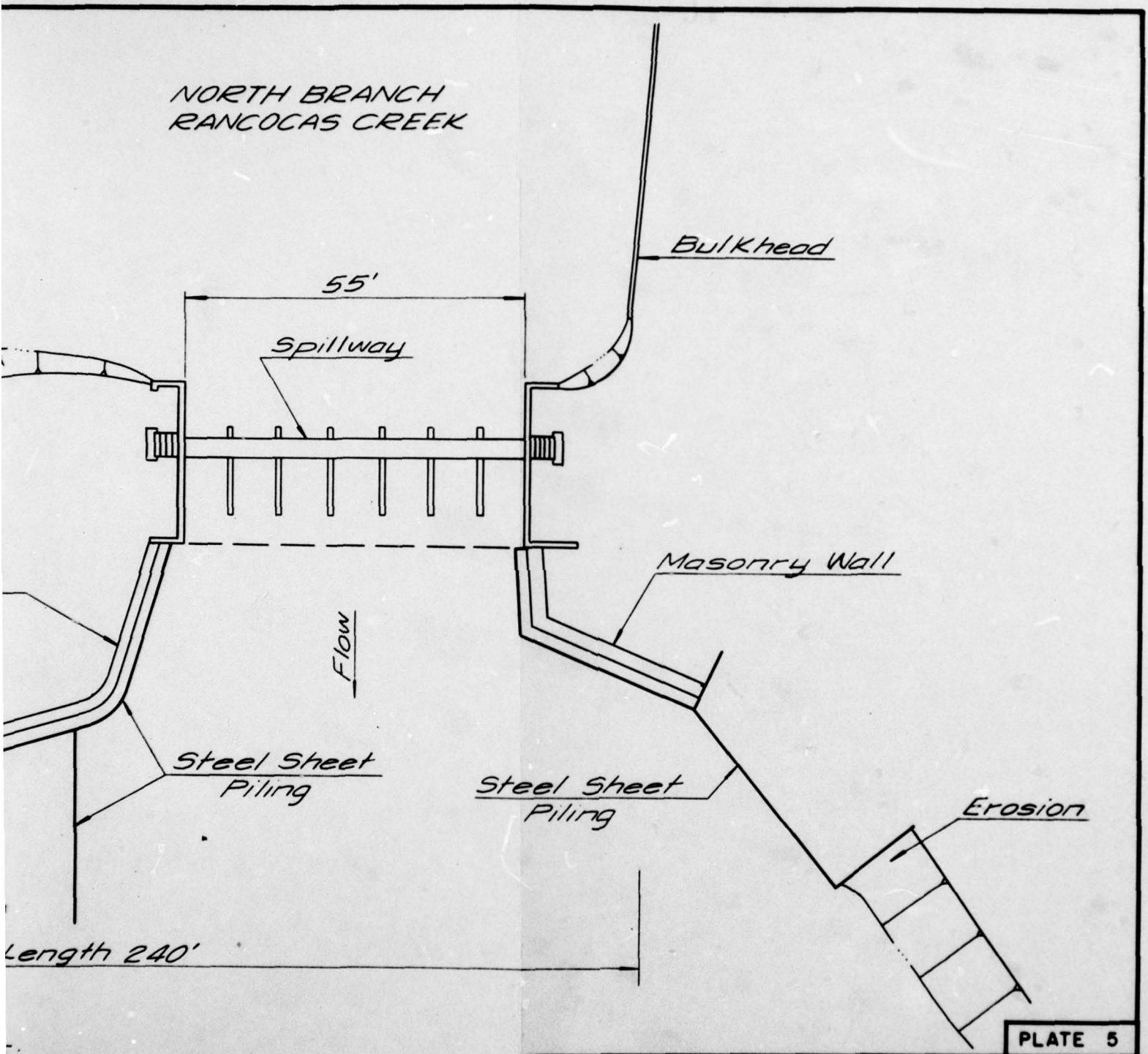
MILL DAM

I.D. N.J. 00540

SCALE: NOT TO SCALE

DATE: MARCH, 1979


Upstream Face
of Embankment
MILL RACE
Grouted Rap-rap
Abandoned
Power
House
Masonry Wall
Masonry Wall
Timber Piling
Steel Sheet
Piling
Dam Crest Length 240
NOTE:
Information t
prepared by K
Associates da
and Field Insp
December 18,



ormation taken from plans
pared by Richard A. Alaimo
ociates dated May 1973
d Field Inspection
ember 18, 1978.

PLATE 5

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

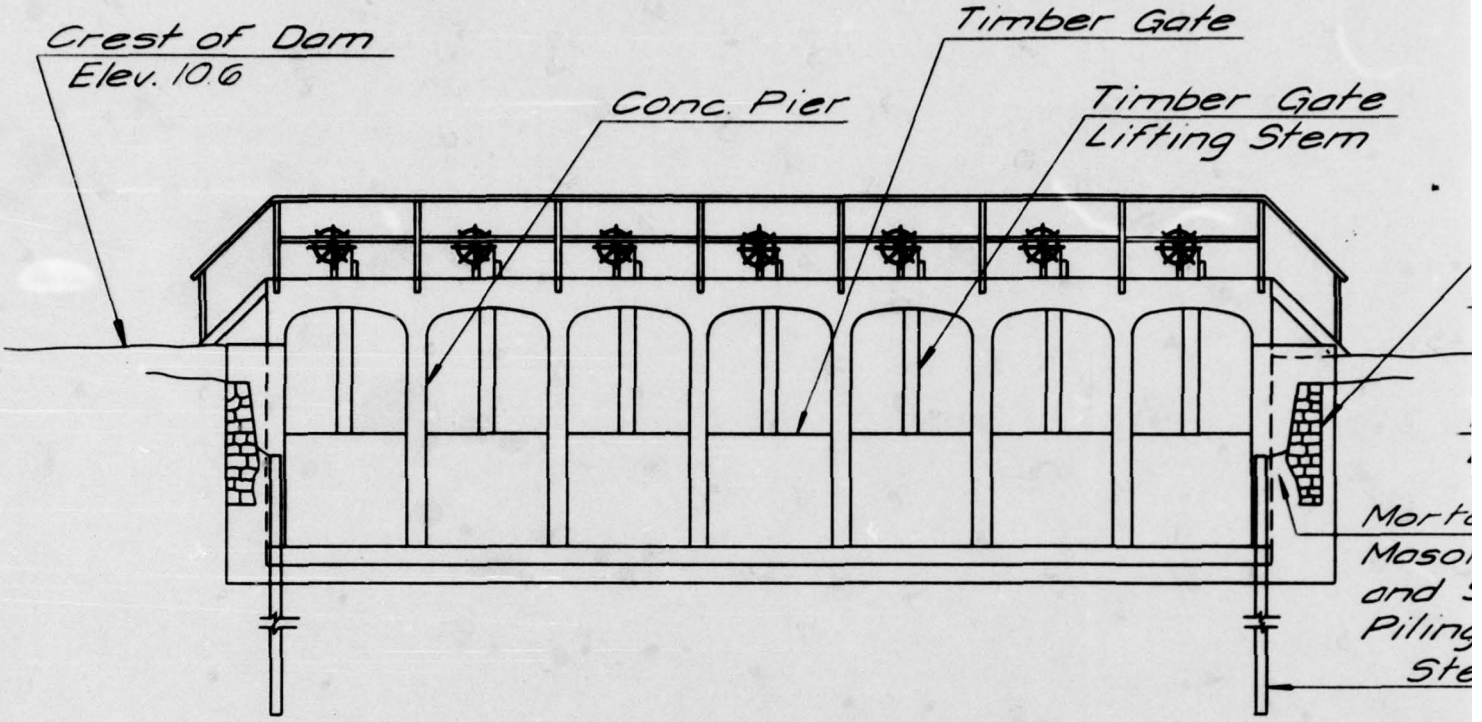
INSPECTION AND EVALUATION OF DAMS

GENERAL PLAN

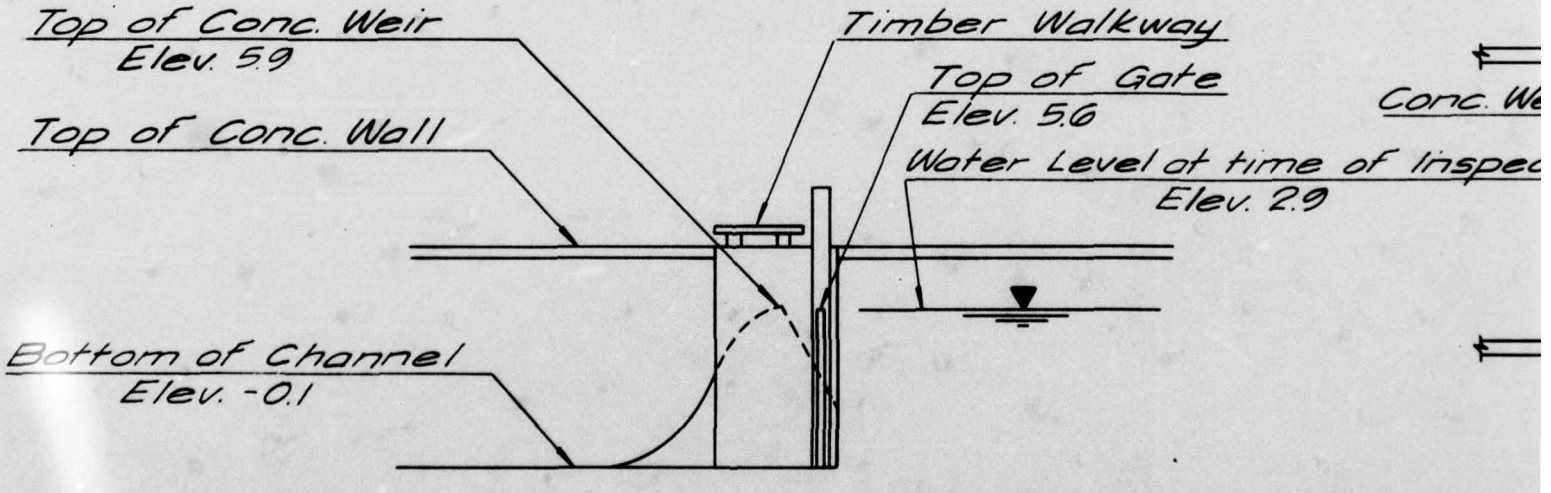
MILL DAM

I.D. N.J. 00540	SCALE: NOT TO SCALE
	DATE: MARCH, 1979

2



SPILLWAY ELEVATION

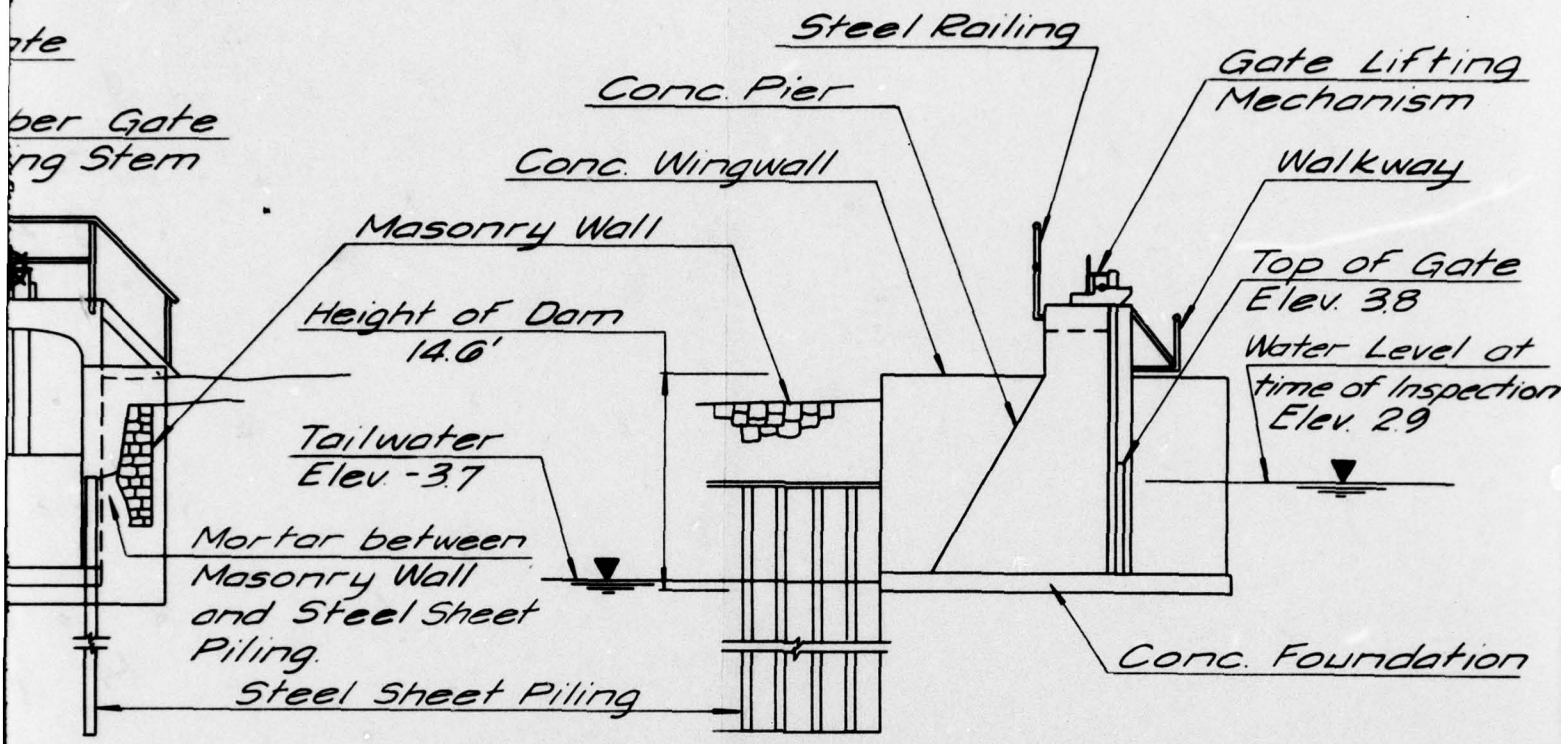


SECTION

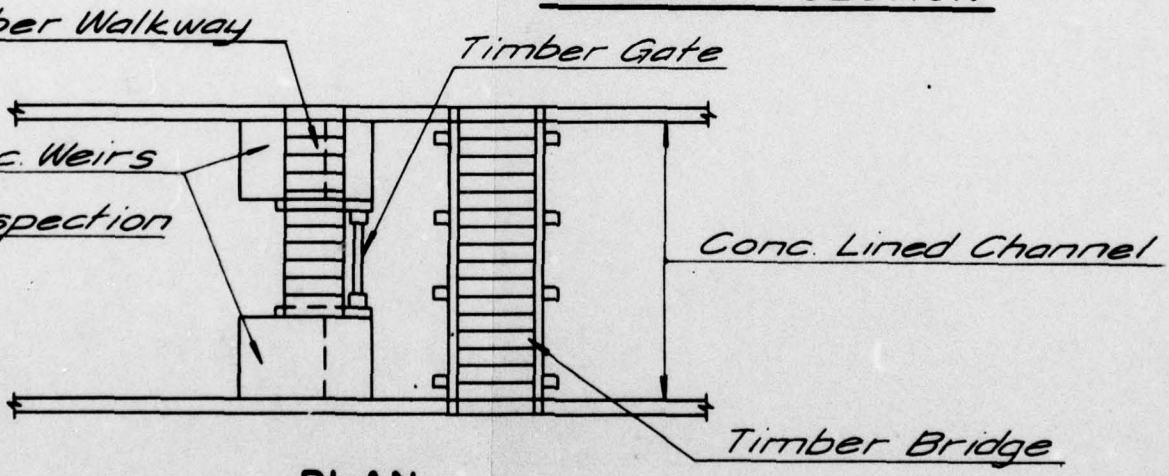
MILL RACE OUTLET WORKS

NOTES:

1. Information taken from plans prepared by Richard A. Alaimo Associates dated May 1973 and Field Inspection December 18,
2. Elevations based on N.G.V.D.



SPILLWAY SECTION



PLAN

MILL RACE OUTLET WORKS

PLATE 6

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

SPILLWAY & OUTLET WORKS

MILL DAM

I.D. N.J. 00540	SCALE: NOT TO SCALE
	DATE: MARCH, 1979

ord A. Alaimo
December 18, 1978.

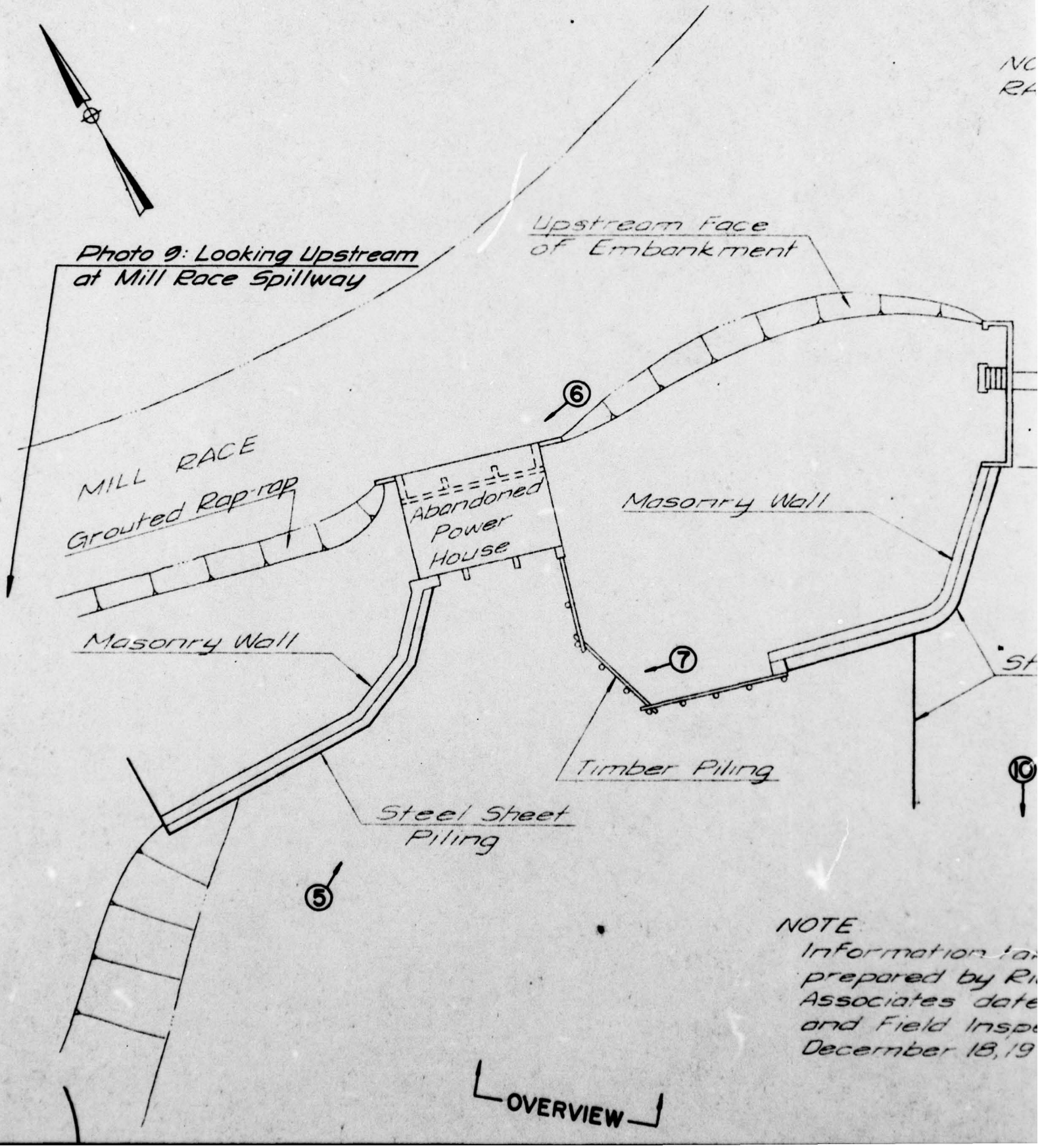


Photo 9: Looking Upstream at Mill Race Spillway
Upstream Face of Embankment
MILL RACE
Grouted Rap-rap
Abandoned Power House
Masonry Wall
Masonry Wall
Timber Piling
Steel Sheet Piling
6
7
5
10
NOTE
Information
prepared by
Associates
and Field
December 18, 19
OVERVIEW

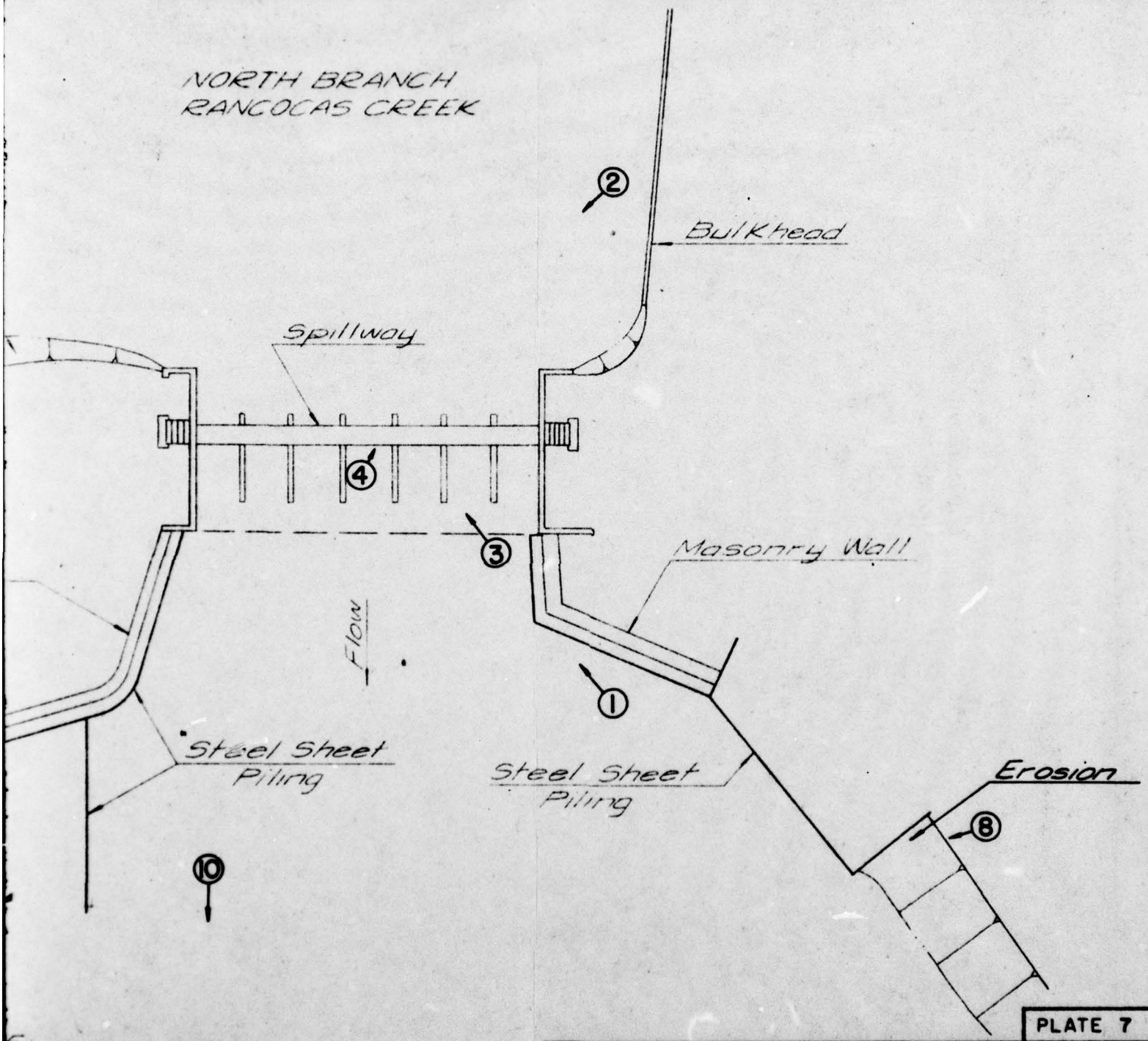


PLATE 7

E
formation taken from plans
epared by Richard A. Alaimo
sociates dated May 1973
d Field Inspection
cember 18, 1978.

2

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

MILL DAM

I.D. N.J. 00540	SCALE: NOT TO SCALE
	DATE: MARCH, 1979

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List
Visual Inspection
Phase 1

Name Dam Mill Dam County Burlington State N.J. Coordinators N.J.D.E.P.

Date(s) Inspection 12/18/78 Weather Sunny Temperature 30°F

Pool Elevation at Time of Inspection 92:9 Assumed Elev. Tailwater at Time of Inspection 86.3 Assumed Elev.

Inspection Personnel:

R. McDermott A. Miller

J. Gribbin

D. Buckelew

J.G. Recorder

Consulted Mr. Robert Casey, Twp. Manager (at his office)

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SEE PAGE ON LEAKAGE	N.A.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	N.A.	
DRAINS	N.A.	
WATER PASSAGES	N.A.	
FOUNDATION	N.A.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N.A.	
STRUCTURAL CRACKING	N.A.	
VERTICAL AND HORIZONTAL ALIGNMENT	N.A.	
MONOLITH JOINTS	N.A.	
CONSTRUCTION JOINTS	N.A.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Erosion of east bank, downstream channel at end of steel sheet pile bulkhead.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Horiz. - irregular but in conformance with construction drawing Vert. - Level	
RIPRAP FAILURES	None	Grouted riprap along upstream face of embankment and south bank of Mill Race generally in satisfactory condition. Sc cracks in grout.

Sheet _

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Embankment generally is grass covered with a few scattered trees and bushes.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Good Condition	
ANY NOTICEABLE SEEPAGE	None	
STAFF GAGE AND RECORDER	None	
DRAINS	None	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	N.A.	
INTAKE STRUCTURE	Same as "Outlet Structure"	
OUTLET STRUCTURE	Seven gates in spillway. The two end gates have never been raised. Of the remaining five, two operate with difficulty, two operate satisfactorily and the gears of one do not mesh properly. The gate on Mill Race operates satisfactorily.	Only the upper section of each of the inner five gates is moveable. One gate is located on Mill Race approx. 850' from dam and is used to completely dra the upstream impoundment.
OUTLET CHANNEL	Spillway gates: outlet channel same as downstream channel of spillway. Mill Race gate: outlet channel is small stream which intersects downstream channel of spillway approx. 3/4 mile downstream of dam.	
EMERGENCY GATE	Same as "Outlet Structure"	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	N.A.	
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	N.A.	
BRIDGE AND PIERS	N.A.	
EMERGENCY SPILLWAY	None	Emergency spillway reportedly to be constructed around east end of dam.

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Concrete severly spalled on most surfaces of top and piers of main spillway structure. Reinforcing exposed at bottom of piers.	
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	Same as Downstream Channel	
BRIDGE AND PIERS	Timber walkway along spillway in satisfactory condition.	
GATES AND OPERATION EQUIPMENT	See "Outlet Works"	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	N.A.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Slopes of the banks of the upstream impoundment are generally flat to gradually sloping.	Mill Dam does not impound a lake - it impounds part of the upstream channel, i. North Branch Rancocas Creek.
SEDIMENTATION	Not known	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Wide shallow stream with graded banks in the vicinity of the dam. No obstructions.	Downstream channel reportedly affected by tides.
SLOPES	Slopes of banks are generally flat to moderately sloping.	
APPROXIMATE NO. OF HOMES AND POPULATION	Stream flows through a park for 1500 feet then through a densely developed commercial area of Mount Holly.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Not Available
REGIONAL VICINITY MAP	USGS Quadrangles: Mount Holly, Pemberton Brown Mills, Whiting, Chatsworth & Cossville.
CONSTRUCTION HISTORY	Not Available
TYPICAL SECTIONS OF DAM	Not Available
HYDROLOGIC/HYDRAULIC DATA	Not Available
OUTLETS - PLAN	Not Available
- DETAILS	
-CONSTRAINTS -DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	Not Available

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Not Available

ITEM	REMARKS
MONITORING SYSTEMS	Not Available
MODIFICATIONS	Reconstruction of Retaining Structures immediately downstream of dam (1973)
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Not Available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Not Available
MAINTENANCE OPERATION RECORDS	Not Available

ITEM	REMARKS
SPILLWAY PLAN	Not Available
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Not Available

APPENDIX 2

Photographs

PHOTO 1

CONCRETE SPILLWAY

PHOTO 2

UPSTREAM VIEW OF SPILLWAY.
TWO GATES RAISED.

18 Dec. 1978

PHOTO 3

FLOW THROUGH TWO GATES OF SPILLWAY

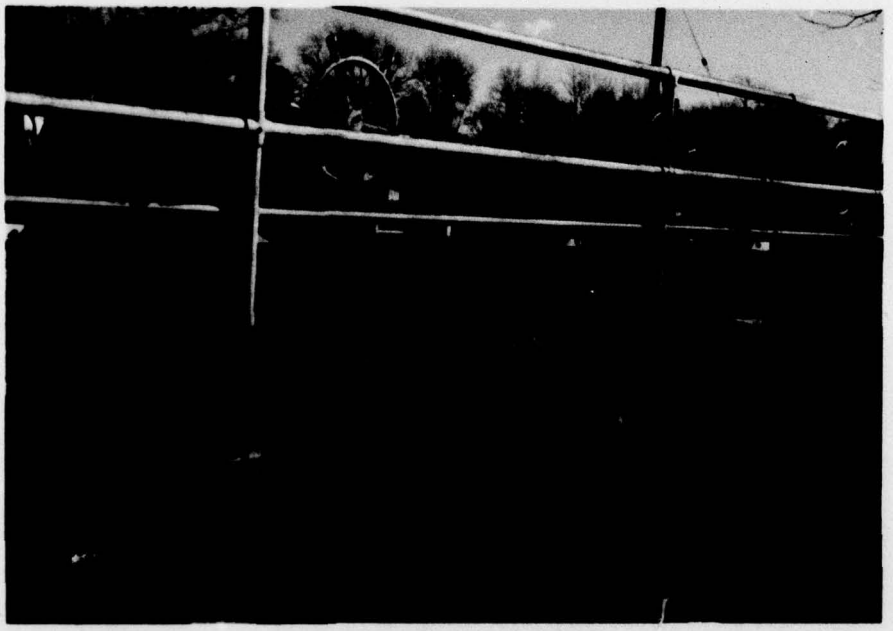


PHOTO 4

SPALLED CONCRETE ON SPILLWAY.
GATE OPERATING MECHANISMS.

18 Dec. 1978

PHOTO 5

DOWNSTREAM VIEW OF ABANDONED POWER HOUSE.
DOWNSTREAM FACE OF EMBANKMENT.

PHOTO 6

UPSTREAM VIEW OF ABANDONED POWER HOUSE.
GROUTED RIPRAP ON UPSTREAM FACE OF EMBANKMENT.

18 Dec. 1978

PHOTO 7

DOWNSTREAM FACE OF DAM - STEEL SHEET PILES AND TIMBER PILES AND WHALERS

PHOTO 8

EROSION OF EAST BANK OF DOWNSTREAM CHANNEL

18 Dec. 1978

PHOTO 9

WEIR AND GATE STRUCTURE ON MILL RACE

PHOTO 10

DOWNSTREAM CHANNEL

18 Dec. 1978

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 144 Square Miles, Rolling, Several Tributary Creeks. Dense Timber growth, numerous impoundments and swampy areas.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 4.0 (NGVD) (182 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 12.9

ELEVATION TOP DAM: 10.6

MILL DAM SPILLWAY: Uncontrolled sharp-crested weir.

a. Elevation 3.8
b. Type Crest of timber slide gates.
c. Width 3 inches
d. Length 50.8 feet (total)
e. Location of Spillover Downstream Apron
f. Number and Type of Gates Seven manual timber slide gates

ABANDON POWER HOUSE SPILLWAY: Uncontrolled sharp-crested weir.

a. Elevation 6.4
b. Type Crest of timber slide gates
c. Width 3 inches
d. Length 21.6 feet (total)
e. Location of Spillover Downstream Apron
f. Number and Type of Gates Three manual timber slide gates (inoperable)

MILL RACE SPILLWAY: Uncontrolled sharp-crested weir.

a. Elevation 5.6 (slide gate) 5.9 (Concrete Weirs)
b. Type Crest of timber slide gate & concrete weirs
c. Width Approximately 3 inches.
d. Length 20 feet (total)
e. Location of Spillover Downstream Apron
f. Number and Type of Gates One manual timber slide gate.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

OUTLET WORKS: Timber Slide Gate at Mill Race

a. Type Manual Timber Slide Gate

b. Location Center of Mill Race Spillway

c. Entrance Invert - 0.1

d. Exit Invert - 0.1

e. Emergency draindown facilities Timber Slide Gate

HYDROMETEOROLOGICAL GAGES: Not Available

a. Type N.A.

b. Location N.A.

c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake stage equal to top of dam) 2666 cfs

APPENDIX 4

Hydrologic Computations

Mill Dam

Size classification

Stream bed elevation immediately downstream of dam		-4.0
Top of dam elevation		10.6
Height of dam	10.6 - (-4.0) =	14.6 ft.
Approx. storage volume at top of dam		927 Ac-ft.
Size classification		Small

Hazard Potential classification

1. Dam is situated in an urban area
2. Failure of the dam can cause serious damage to homes, industries, roads and commercial establishments.

Classification high hazard

SDF ½ PMF to PMF, use ½ PMF

Downstream Tidal Stage

Since the greatest hydraulic differential between the upstream and downstream water levels will exist at low tide, the analysis will be performed for low tide.

EL. (ft)	Surface Area (Ac)
-2.4	0
3.8	37
20.0	265

Average depth of lake at normal pool
= 3.1 ft.

Average depth of lake at top of dam
= 6.6 ft.

Surface area at EL 10.6 (Est.)

$$\frac{A}{265} = \frac{10.6}{20}$$

$A = 140.5$ Ac

Storage $= 6.6 \times 140.5$

$= \underline{927}$ Ac-ft.

HYDROLOGY

Unit hydrograph for Mill Pond will be developed using Clark's parameters calculated from the following regression equations :-

$$T_c + R = 21.0 \left(DA/S\right)^{0.22} \left(S_t\right)^{0.33} \left(1.0 + 0.3I\right)^{-0.28}$$

$$\frac{R}{T_c + R} = 0.76$$

where I = % impervious

DA = Drainage Area (Sq. Mi.)

S = Average channel slope between the points 10 and 85 percent of the distance upstream from the outflow point (dam) to the watershed boundary (ft/mi).

S_t = % Storage area (Lakes and Swamps).

1. DRAINAGE AREA

Drainage area as measured from Geological Survey maps } = 144 Sq. Mi

2. AVERAGE CHANNEL SLOPE

Length : Mount Holly quad. = 3.4 Miles
Pemberton quad. = 9.3 Miles
Browns Mills quad = 6.9 Miles
Whiting quad = 7.6 Miles

Total length = 27.2 Miles

Elevation at a distance of 2.72 Miles from Dam } = 20 Ft

Elevation at a distance of 23.12 Miles from Dam } = 120 Ft

Average Channel Slope $= \frac{120-20}{23.12-2.72} = \frac{100}{20.4}$

$= 4.90$ Ft/Mi

3 STORAGE AREA :-

Quadrangles :

Mount Holly	=	0.126	Sq Mi
Pemberton	=	0.110	Sq Mi
Browns Mills	=	3.933	Sq Mi
Whiting	=	7.161	Sq Mi
Chatsworth	=	0.151	Sq Mi
Cassville	=	0.489	Sq Mi
Total		11.97	Sq Mi

$S_t = \frac{11.97}{144} \times 100 = 8.31\ \%$

4 POPULATION :-

Mount Holly	1.000
Eastampton	2.284
Springfield	2.244
Pemberton Boro	1.344
Pemberton Twp	19.754
New Hanover Twp	27.410

Continued . .

Continued..

Woodland Twp	2,032
Total	56,068
Increase 70 to 79 say	5,600
Total	61,668

Population density = $\frac{61,668}{144}$ = 428 persons/sq. mi.

Impervious Cover Index $I = 0.117[D]^{0.792-0.039\log_{10}D}$

$= 0.117[428]^{0.792-0.103}$

$= 0.117[428]^{0.689}$

$= 7.61\ \%$

5 Unit Hydrograph Parameters:

$$T_c + R = 21.0\left(\frac{DA}{S}\right)^{0.22}(S_t)^{0.33}(1.0+0.3I)^{-0.28}$$

$$= 21.0\left(\frac{144}{4.90}\right)^{0.22}(8.31)^{0.33}(1.0+0.3\times7.61)^{-0.28}$$

$$= 21.0\,(29.39)^{0.22}(8.31)^{0.33}(3.283)^{-0.28}$$

$$= 21.0\,(2.104)(2.011)(0.717)$$

$$= 63.7$$

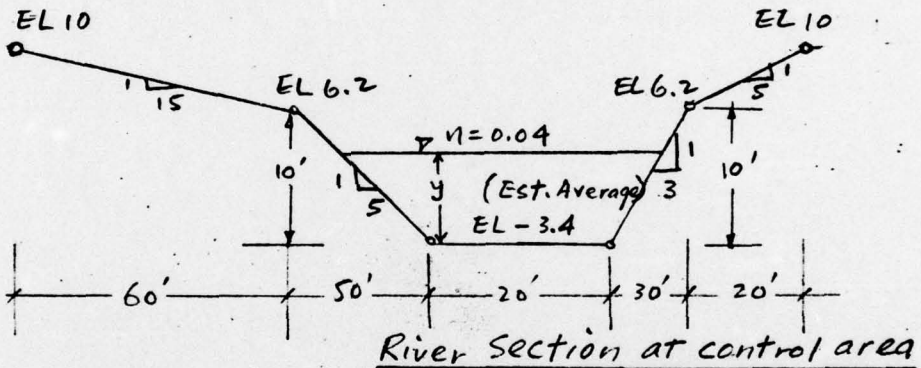
$$\frac{R}{T_c+R} = 0.76$$

$\therefore R = 0.76 \times 63.7 = \underline{48.4\ \text{Hrs.}}$

$T_c = 63.7 - 48.4 = \underline{15.3\ \text{Hrs.}}$

Tailwater Height Calculation

The height of tailwater vs. discharge will be calculated by using Manning's equation applied to a river section 600' downstream of Mill dam and the power house. At this location, the creek channel and flood plain are most restricted, and flow will be controlled in this area. Approx. Creek invert = -3.4'



River Section at control area

use $n = 0.04$

Slope of river bed 0.0006 (Estimated), $S^{1/2} = 0.024$

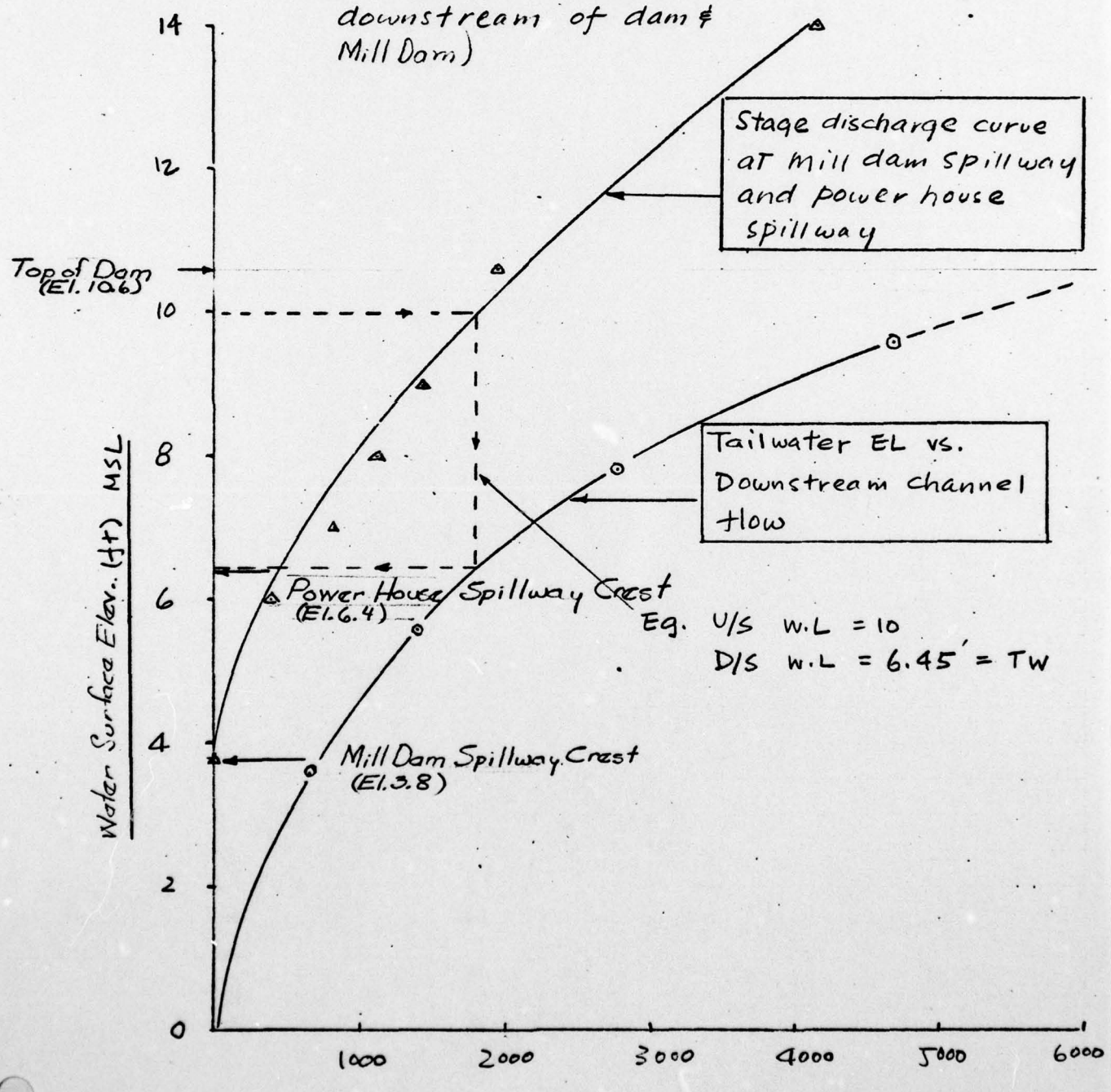
$$Q = \frac{1.49}{n} A R^{2/3} (S)^{1/2}$$

Low tide W.L. -3.2'*

Q(cfs)	A (S.F.)	P (Ft.)	R = A/P	Tailwater Elevation
145	96	34.4	2.8	-0.4
797	336	77.8	4.32	3.6
1376	504	94.3	5.34	5.6
2720	854	127	6.7	7.8
4675	1290	163	7.9	9.6

*(Assume initial creek water level negligible at low Tide)

Stage vs Flow Curves
(at channel section 600' downstream of dam & Mill Dam)



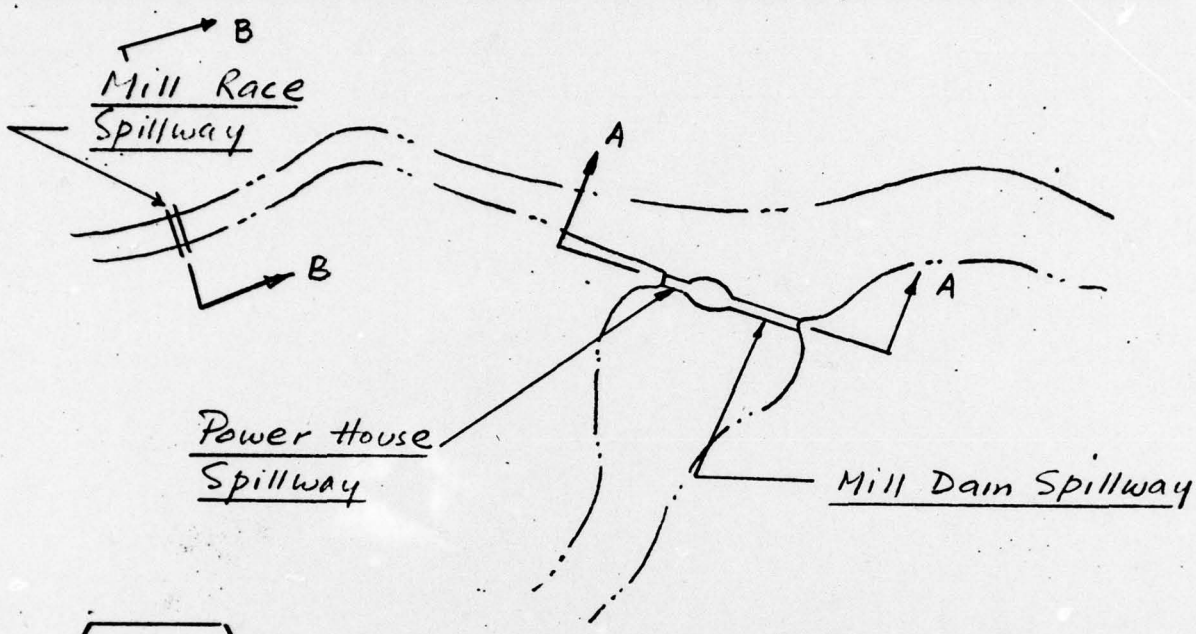
STORCH ENGINEERS

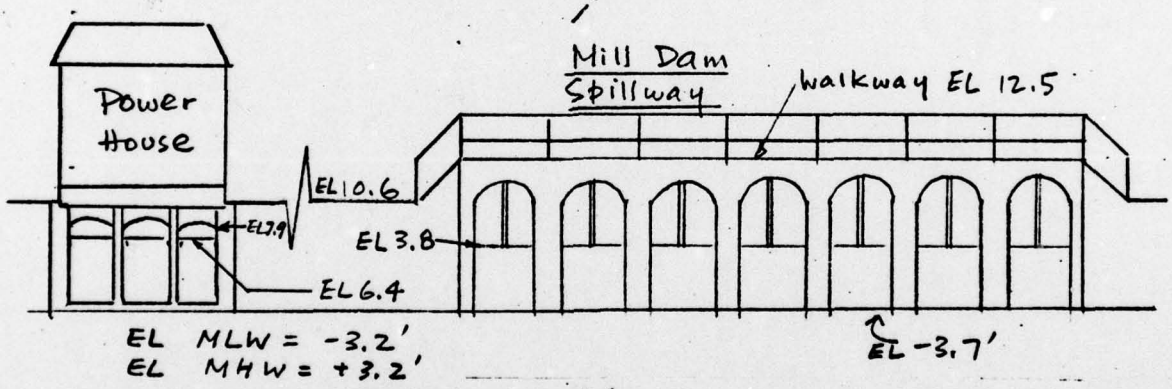
Sheet 8 of 17

Project Mill Dam 1132

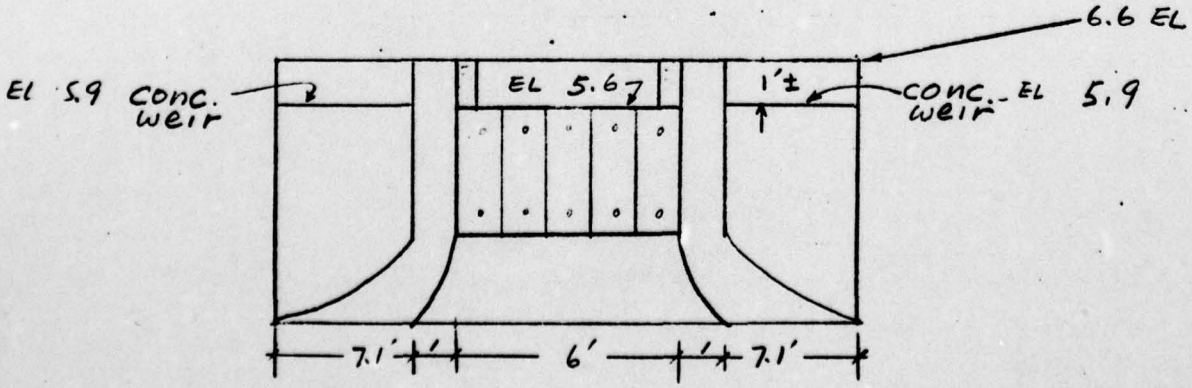
Made By RL Date 4-10-79

Chkd By Date





SECTION AA



SECTION BB (Mill Race Spillway)

HYDRAULICS

MILL DAM SPILLWAY

The effective length of crest will be calculated by the following formula :-

$$L = L' - 2(NK_p + K_a)H_e$$

where : L = effective length of crest
L' = net length of crest
N = number of piers
K_p = pier contraction coefficient
K_a = abutment contraction coefficient
H_e = total head on crest.

$$L' = 14\left(\frac{7 - 0.83}{2}\right) = 43.2 \text{ Ft}$$

$$N = 13$$

$$K_p = 0.02$$

$$K_a = 0.20$$

$$\therefore L = 43.2 - 2(13 \times 0.02 + 0.20)H_e$$

$$= 43.2 - 0.92 H_e$$

The discharge over the crest will be calculated by the following formula :

$$Q = C L H_e^{3/2}$$

Weir crest elevation 3.8'

Mill Dam Spillway

HW. EL. (Ft.)	He	L	$He^{3/2}$ C = 3.3	T.W. (Ft)	Q weir (cfs)	Q Submerged (cfs)
3.8	0	0	0	-	0	—
4.0	0.2	43.0	0.089	-	13	—
5.0	1.2	42.1	1.315	-	183	—
6.0	2.2	41.2	3.263	-	444	—
7.0	3.2	40.3	5.724	-	761	—
8.0	4.2	39.3	8.607	5.0 (Est)*	1116	971
9.0	5.2	38.4	11.86	5.6	1503	1263
10.6	6.8	36.9	17.73	6.8	2159	1684
12.0	8.2	35.7	23.5	7.2	2766	2268
13.0**	—	A = 336 S.F.		8.5	Orifice	3432
14.0***	—	A = 336 SF		8.8		3926

He = HW - 3.8'

* Estimated tailwater elevation (Weir submerged). Q sub. weir is obtained by applying ajustment according to Chart on Pg 5-18 "Handbook of Hydraulics" by King & Brater

** Orifice flow starts at tailwater elevation = 13.0
Where $Q = cA\sqrt{2g\Delta h}$ A = 336 S.F.

C = 0.6 Δh = HW - TW

*** For W.L = 14.0 Orifice flow = 3689 CFS
Walkway overflow = 237 CFS
Total = 3926 CFS

Power House Spillway

The effective length of crest will be calculated by the following formula

$$L = L' - 2(NKp + Ka)He$$

$$L' = 6\left(\frac{7.2 - 0.83}{2}\right) = 19.11 \text{ ft.}$$

$N = 5$

$Kp = 0.02$

$Ka = 0.2$

$$\therefore L = 19.11 - 2(5 \times 0.02 + 0.2)He$$

$$= 19.11 - 0.6He$$

Discharge over the crest will be calculated by the following formula:

$Q = CLHe^{3/2}$ Weir crest el. = 6.4'

$C = 3.3$

Orifice flow: $Q = Ca\sqrt{2gh}$

or $Q = Ca\sqrt{2g\Delta h}$

$\Delta h = HW - TW$

$q = 6 \times 3.2 \times 1.5 = 28.8$ S.F.

Weir crest elevation = 6.4'

AD-A068 590 NEW JERSEY STATE DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/2
NATIONAL DAM SAFETY PROGRAM. MILL DAM (NJ00540), DELAWARE RIVER--ETC(U)
MAY 79 R J MCDERMOTT DACW61-78-C-0124

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2 OF 2
AD
A068 590

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DATE
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6-79
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Power House Spillway

HW EL. (ft)	TYPE OF FLOW.	TW EL (ft)	L (ft)	(He) (ft)	Q (CFS)
6.4		-	-	-	0
	weir flow				
7.0	over gates	-	18.75	0.6	29
	c = 3.3				
7.9	(Top of openning)	-	18.21	1.5	110
				(h)	
8.0	C = 0.6	5.0		0.85	128
	Orifice				
8.1	flow	5.0		0.95	135
9.0	a = 28.8 S.F.	5.6		1.85	189
				Δh	
10.6		6.8*		3.8	270
	Orifice			Δh	
14.0	flow	8.8		5.2	316

* Weir submerged

Tw = Estimated tailwater elevations for Mill Dam Spillway Analysis

He = head over weir

h = head for orifice flow

Δh = difference in head Hw ~ Tw for orifice flow

Mill Race Spillway

Flow over the concrete weir sections :

$Q_1 = C_o L H^{3/2}$

$L = 2 \times 7.1 = 14.2$ ft

C_o from fig 249 "Design of Small Dam"

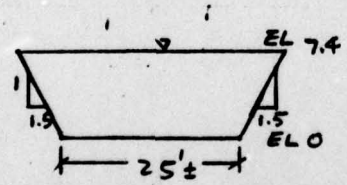
Flow over timber gate (center section)

$Q_2 = C L H^{3/2}$

$L = 6.0 - 2 \times 0.2H = 6.0 - 0.4H$

$C = 3.3$

Downstream Mill Race Channel Capacity



Typical channel section

$S \approx 0.005$ (Est.)
$n = 0.03$
AT. W.L. 7.4
$A = 267$ S.F.
$P = 51.7$
$R = 5.17$

$$Q = \frac{1.49}{0.03} (5.17)^{2/3} (0.005)^{1/2} \times 267$$

$= 2803$ CFS >>> Spillway Discharge

∴ Ignore tailwater.

Mill Race Spillway

Mill Race Channel discharges into Rancocas Creek ≈ 4000' downstream from Mill Dam Spillway

$L = 14.2$ $L = 6 - 0.4h_2$

W.L (ft)	h_1	C_o	Q_1 conc weir	h_2	L	Q_2 gate	total Q (CFS)
5.6	0	-	0	0	-	-	0
5.9	0	-	0	0.3	5.9	3	3
6.0	0.1	3.95	2	0.4	5.8	5	7
7.0	1.1	3.95	65	1.4	5.4	30	95
8.0	2.1	3.95	171	2.4	5.0	61	232
9.0	3.1	3.9	306	3.4	4.6	95	401
10.6	4.7	3.9	564	5.0	4.0	148	712
14.0	8.1	3.85	1260	8.4	2.6	209	1469

C_o from Pg 378 "Design of Small Dam"

Stage Discharge Tabulation for all Controls

WL	Mill Dam. Q_1	Power House Q_2	$Q_1 + Q_2$	Mill Race Q_3	ΣQ
3.8	0	0	0	0	0
6.0	444	0	444	7	451
7.0	761	29	790	95	885
8.0	971	128	1099	232	1331
9.0	1263	189	1452	401	1853
10.6	1684	270	1954	712	2666
14.0	3926	316	4242	1469	5711

STORCH ENGINEERS

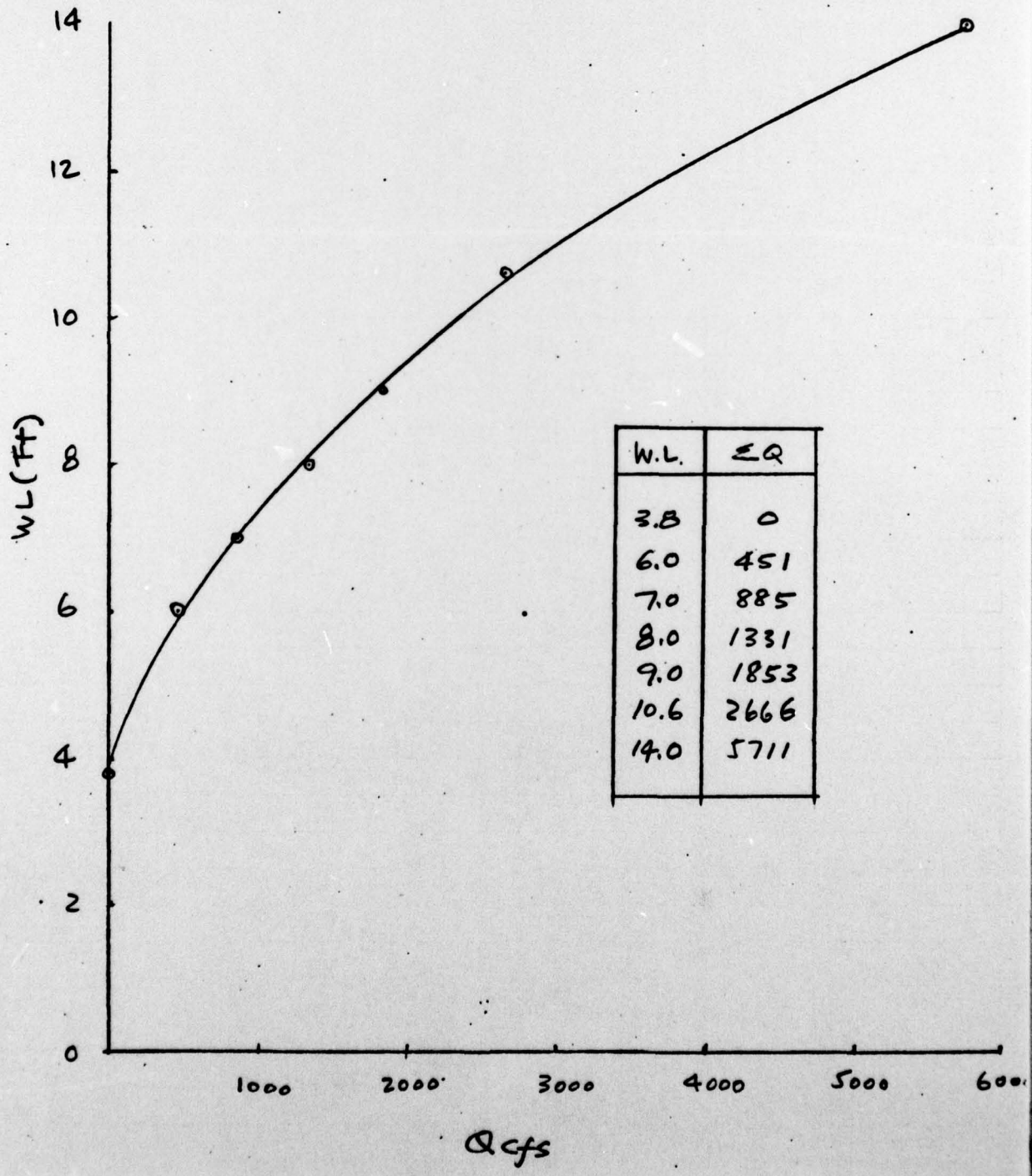
Sheet 16 of 17

Project Mill Dam 1132

Made By RL Date 4-12-79

Chkd By _____ Date _____

STAGE DISCHARGE CURVE



W.L.	ΣQ
3.8	0
6.0	451
7.0	885
8.0	1331
9.0	1853
10.6	2666
14.0	5711

HEC-1-DB COMPUTATIONS

```
A1                              NATIONAL DAM SAFETY PROGRAM
A2                         MILL DAM, MOUNT HOLLY, NEW JERSEY
A3                                  PMF STORM ROUTING.
B      300         1         0                                       0         0         3
B1       5
J        1         5         1
J1     0.5       3.4       0.3       0.2       0.1
K        0      MILL                                   0         0         1
K1                         INFLOW HYDROGRAPH TO MILL DAM
M        1         0       144                 144         0                             1
P        0      26.5        77        84        92
T                                                                  1.5       .15
W     15.3      49.4         0
X     -1.0     -0.05       2.0
K        1       DAM                                   0         0         1
K1                         ROUTED DISCHARGE THROUGH MILL DAM
Y                                      1         1
Y1       1                                                        -3.8        -1
Y4     3.8         6         7         8         9      10.6        14
Y5       0       451       885      1331      1853      2666      5711
$A    14.3        37       265
$E       0       3.8      20.0
$$     3.8
$D    10.6      2.63       1.5      1000
K       99
A
A
A
A
A
A
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION    JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN DATE= 79/09/12.
TIME= 16.12.41.
```

NATIONAL DAM SAFETY PROGRAM
MILL DAM, MOUNT HOLLY, NEW JERSEY
PMF STORM ROUTING.

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	1	0	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 5 LRTIO= 1

RTIOS= .50 .40 .30 .20 .10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH TO MILL DAM

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
MILL	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	0	144.00	0.00	144.00	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.50	77.00	84.00	92.00	0.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .875

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.50	.15	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 15.30 R= 48.40 NTA= 0

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 100 END-OF-PERIOD ORDINATES, LAG= 15.46 HOURS, CP= .26 VOL= .85

22.	85.	178.	290.	419.	560.	714.	876.	1038.	1185.
1316.	1428.	1521.	1591.	1633.	1633.	1603.	1570.	1538.	1507.
1476.	1446.	1415.	1387.	1359.	1331.	1304.	1277.	1251.	1225.
1200.	1176.	1152.	1128.	1105.	1083.	1060.	1039.	1018.	997.
976.	956.	937.	918.	899.	881.	862.	845.	828.	811.
794.	778.	762.	746.	731.	716.	701.	687.	673.	659.
646.	633.	620.	607.	595.	582.	571.	559.	547.	536.
525.	515.	504.	494.	484.	474.	464.	455.	445.	436.
427.	418.	410.	402.	393.	385.	377.	370.	362.	355.
347.	340.	333.	327.	320.	313.	307.	301.	295.	289.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	1.00	1	.12	0.00	.12	134.
1.01	2.00	2	.12	0.00	.12	125.
1.01	3.00	3	.12	0.00	.12	117.
1.01	4.00	4	.12	0.00	.12	109.
1.01	5.00	5	.12	0.00	.12	102.
1.01	6.00	6	.12	0.00	.12	95.
1.01	7.00	7	.27	0.00	.27	89.
1.01	8.00	8	.27	0.00	.27	83.
1.01	9.00	9	.27	.02	.25	78.
1.01	10.00	10	.27	.12	.15	77.
1.01	11.00	11	.27	.12	.15	84.
1.01	12.00	12	.27	.12	.15	104.
1.01	13.00	13	1.79	1.64	.15	172.
1.01	14.00	14	2.14	1.99	.15	360.
1.01	15.00	15	2.68	2.53	.15	739.
1.01	16.00	16	6.79	6.64	.15	1467.
1.01	17.00	17	2.50	2.35	.15	2662.
1.01	18.00	18	1.96	1.81	.15	4295.
1.01	19.00	19	.19	.04	.13	5298.
1.01	20.00	20	.19	.04	.15	8558.
1.01	21.00	21	.19	.04	.15	11034.
1.01	22.00	22	.19	.04	.15	13641.
1.01	23.00	23	.19	.04	.15	16301.
1.02	0.00	24	.19	.04	.15	18892.
1.02	1.00	25	0.00	0.00	0.00	21286.
1.02	2.00	26	0.00	0.00	0.00	23403.
1.02	3.00	27	0.00	0.00	0.00	25187.
1.02	4.00	28	0.00	0.00	0.00	25582.
1.02	5.00	29	0.00	0.00	0.00	27545.
1.02	6.00	30	0.00	0.00	0.00	28062.
1.02	7.00	31	0.00	0.00	0.00	28110.
1.02	8.00	32	0.00	0.00	0.00	27803.
1.02	9.00	33	0.00	0.00	0.00	27330.
1.02	10.00	34	0.00	0.00	0.00	26799.
1.02	11.00	35	0.00	0.00	0.00	26267.
1.02	12.00	36	0.00	0.00	0.00	25741.
1.02	13.00	37	0.00	0.00	0.00	25222.
1.02	14.00	38	0.00	0.00	0.00	24710.
1.02	15.00	39	0.00	0.00	0.00	24205.
1.02	16.00	40	0.00	0.00	0.00	23710.
1.02	17.00	41	0.00	0.00	0.00	23225.
1.02	18.00	42	0.00	0.00	0.00	22749.
1.02	19.00	43	0.00	0.00	0.00	22284.
1.02	20.00	44	0.00	0.00	0.00	21828.
1.02	21.00	45	0.00	0.00	0.00	21381.
1.02	22.00	46	0.00	0.00	0.00	20943.
1.02	23.00	47	0.00	0.00	0.00	20515.
1.03	0.00	48	0.00	0.00	0.00	20095.
1.03	1.00	49	0.00	0.00	0.00	19684.
1.03	2.00	50	0.00	0.00	0.00	19281.
1.03	3.00	51	0.00	0.00	0.00	18887.
1.03	4.00	52	0.00	0.00	0.00	18500.
1.03	5.00	53	0.00	0.00	0.00	18122.
1.03	6.00	54	0.00	0.00	0.00	17751.
1.03	7.00	55	0.00	0.00	0.00	17388.
1.03	8.00	56	0.00	0.00	0.00	17032.
1.03	9.00	57	0.00	0.00	0.00	15684.
1.03	10.00	58	0.00	0.00	0.00	16342.
1.03	11.00	59	0.00	0.00	0.00	16008.
1.03	12.00	60	0.00	0.00	0.00	15681.
1.03	13.00	61	0.00	0.00	0.00	15360.
1.03	14.00	62	0.00	0.00	0.00	15046.
1.03	15.00	63	0.00	0.00	0.00	14738.
1.03	16.00	64	0.00	0.00	0.00	14436.
1.03	17.00	65	0.00	0.00	0.00	14141.
1.03	18.00	66	0.00	0.00	0.00	13852.
1.03	19.00	67	0.00	0.00	0.00	13568.
1.03	20.00	68	0.00	0.00	0.00	13291.
1.03	21.00	69	0.00	0.00	0.00	13019.
1.03	22.00	70	0.00	0.00	0.00	12753.
1.03	23.00	71	0.00	0.00	0.00	12492.
1.07	7.00	151	0.00	0.00	0.00	124.
1.07	8.00	152	0.00	0.00	0.00	115.
1.07	9.00	153	0.00	0.00	0.00	108.
1.07	10.00	154	0.00	0.00	0.00	100.
1.07	11.00	155	0.00	0.00	0.00	94.
1.07	12.00	156	0.00	0.00	0.00	87.
1.07	13.00	157	0.00	0.00	0.00	82.
1.07	14.00	158	0.00	0.00	0.00	76.
1.07	15.00	159	0.00	0.00	0.00	71.
1.07	16.00	160	0.00	0.00	0.00	66.
1.07	17.00	161	0.00	0.00	0.00	62.
1.07	18.00	162	0.00	0.00	0.00	58.
1.07	19.00	163	0.00	0.00	0.00	54.
1.07	20.00	164	0.00	0.00	0.00	50.
1.07	21.00	165	0.00	0.00	0.00	47.
1.07	22.00	166	0.00	0.00	0.00	44.
1.07	23.00	167	0.00	0.00	0.00	41.
1.08	0.00	168	0.00	0.00	0.00	38.
1.08	1.00	169	0.00	0.00	0.00	36.
1.08	2.00	170	0.00	0.00	0.00	33.
1.08	3.00	171	0.00	0.00	0.00	31.
1.08	4.00	172	0.00	0.00	0.00	29.
1.08	5.00	173	0.00	0.00	0.00	27.
1.08	6.00	174	0.00	0.00	0.00	25.
1.08	7.00	175	0.00	0.00	0.00	23.
1.08	8.00	176	0.00	0.00	0.00	22.
1.08	9.00	177	0.00	0.00	0.00	20.
1.08	10.00	178	0.00	0.00	0.00	19.
1.08	11.00	179	0.00	0.00	0.00	18.
1.08	12.00	180	0.00	0.00	0.00	17.
1.08	13.00	181	0.00	0.00	0.00	15.
1.08	14.00	182	0.00	0.00	0.00	14.
1.08	15.00	183	0.00	0.00	0.00	13.
1.08	16.00	184	0.00	0.00	0.00	13.
1.08	17.00	185	0.00	0.00	0.00	12.
1.08	18.00	186	0.00	0.00	0.00	11.
1.08	19.00	187	0.00	0.00	0.00	10.
1.08	20.00	188	0.00	0.00	0.00	10.
1.08	21.00	189	0.00	0.00	0.00	9.
1.08	22.00	190	0.00	0.00	0.00	8.
1.08	23.00	191	0.00	0.00	0.00	8.
1.09	0.00	192	0.00	0.00	0.00	7.
1.09	1.00	193	0.00	0.00	0.00	7.
1.09	2.00	194	0.00	0.00	0.00	6.
1.09	3.00	195	0.00	0.00	0.00	6.
1.09	4.00	196	0.00	0.00	0.00	5.
1.09	5.00	197	0.00	0.00	0.00	5.
1.09	6.00	198	0.00	0.00	0.00	5.
1.09	7.00	199	0.00	0.00	0.00	4.
1.09	8.00	200	0.00	0.00	0.00	4.
1.09	9.00	201	0.00	0.00	0.00	4.
1.09	10.00	202	0.00	0.00	0.00	4.
1.09	11.00	203	0.00	0.00	0.00	3.
1.09	12.00	204	0.00	0.00	0.00	3.
1.09	13.00	205	0.00	0.00	0.00	3.
1.09	14.00	206	0.00	0.00	0.00	3.
1.09	15.00	207	0.00	0.00	0.00	3.
1.09	16.00	208	0.00	0.00	0.00	2.
1.09	17.00	209	0.00	0.00	0.00	2.
1.09	18.00	210	0.00	0.00	0.00	2.
1.09	19.00	211	0.00	0.00	0.00	2.
1.09	20.00	212	0.00	0.00	0.00	2.
1.09	21.00	213	0.00	0.00	0.00	2.
1.09	22.00	214	0.00	0.00	0.00	2.
1.09	23.00	215	0.00	0.00	0.00	1.
1.10	0.00	216	0.00	0.00	0.00	1.
1.10	1.00	217	0.00	0.00	0.00	1.
1.10	2.00	218	0.00	0.00	0.00	1.
1.10	3.00	219	0.00	0.00	0.00	1.
1.10	4.00	220	0.00	0.00	0.00	1.
1.10	5.00	221	0.00	0.00	0.00	1.

1.06	12.00	132	0.00	0.00	0.00	452.	1.12	18.00	282	0.00	0.00	0.00	0.
1.06	13.00	133	0.00	0.00	0.00	431.	1.12	19.00	283	0.00	0.00	0.00	0.
1.06	14.00	134	0.00	0.00	0.00	402.	1.12	20.00	284	0.00	0.00	0.00	0.
1.06	15.00	135	0.00	0.00	0.00	375.	1.12	21.00	285	0.00	0.00	0.00	0.
1.06	16.00	136	0.00	0.00	0.00	350.	1.12	22.00	286	0.00	0.00	0.00	0.
1.06	17.00	137	0.00	0.00	0.00	326.	1.12	23.00	287	0.00	0.00	0.00	0.
1.06	18.00	138	0.00	0.00	0.00	305.	1.13	0.00	288	0.00	0.00	0.00	0.
1.06	19.00	139	0.00	0.00	0.00	284.	1.13	1.00	289	0.00	0.00	0.00	0.
1.06	20.00	140	0.00	0.00	0.00	265.	1.13	2.00	290	0.00	0.00	0.00	0.
1.06	21.00	141	0.00	0.00	0.00	247.	1.13	3.00	291	0.00	0.00	0.00	0.
1.06	22.00	142	0.00	0.00	0.00	231.	1.13	4.00	292	0.00	0.00	0.00	0.
1.06	23.00	143	0.00	0.00	0.00	215.	1.13	5.00	293	0.00	0.00	0.00	0.
1.07	0.00	144	0.00	0.00	0.00	201.	1.13	6.00	294	0.00	0.00	0.00	0.
1.07	1.00	145	0.00	0.00	0.00	187.	1.13	7.00	295	0.00	0.00	0.00	0.
1.07	2.00	146	0.00	0.00	0.00	175.	1.13	8.00	296	0.00	0.00	0.00	0.
1.07	3.00	147	0.00	0.00	0.00	163.	1.13	9.00	297	0.00	0.00	0.00	0.
1.07	4.00	148	0.00	0.00	0.00	152.	1.13	10.00	298	0.00	0.00	0.00	0.
1.07	5.00	149	0.00	0.00	0.00	142.	1.13	11.00	299	0.00	0.00	0.00	0.
1.07	6.00	150	0.00	0.00	0.00	133.	1.13	12.00	300	0.00	0.00	0.00	0.
									SUM	21.34	17.56	3.78	1409091.
										(542.)	(446.)	(96.)	(39901.01)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	28110.	27590.	24349.	16941.	1409027.
CMS	796.	781.	689.	480.	39899.
INCHES		1.78	6.29	13.13	15.17
MM		45.27	159.81	333.57	385.33
AC-FT		13681.	48296.	100807.	116449.
THOUS CU M		16875.	59572.	124344.	143637.

HYDROGRAPH AT STA MILL FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14055.	13795.	12175.	8471.	704514.
CMS	398.	391.	345.	240.	19950.
INCHES		.89	3.15	6.57	7.59
MM		22.64	79.91	166.79	192.66
AC-FT		6841.	24148.	50404.	58224.
THOUS CU M		8438.	29786.	52172.	71819.

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HYDROGRAPH ROUTING

ROUTED DISCHARGE THROUGH MILL DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-0.	-1

STAGE	3.80	6.00	7.00	8.00	9.00	10.60	14.00
FLOW	0.00	451.00	885.00	1331.00	1853.00	2666.00	5711.00
SURFACE AREA=	14.	37.	265.				
CAPACITY=	0.	94.	2260.				
ELEVATION=	0.	4.	20.				

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
3.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
10.6	2.6	1.5	1000.

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

25.	39.	47.	50.	51.	50.	49.	47.	44.	42.
42.	44.	53.	81.	147.	274.	514.	1059.	1718.	2454.
4569.	6526.	7744.	9106.	10335.	11441.	12390.	13131.	13668.	13980.
14064.	13949.	13729.	13467.	13200.	12937.	12677.	12420.	12167.	11918.
11675.	11436.	11202.	10973.	10749.	10529.	10314.	10103.	9897.	9695.
9497.	9303.	9113.	8926.	8744.	8565.	8391.	8219.	8051.	7887.
7726.	7568.	7414.	7262.	7114.	6969.	6827.	6687.	6551.	6417.
6286.	6158.	6032.	5909.	5789.	5671.	5555.	5442.	5331.	5222.
5116.	5012.	4910.	4810.	4712.	4616.	4522.	4430.	4340.	4251.
4165.	4080.	3997.	3916.	3837.	3759.	3683.	3608.	3535.	3463.
3393.	3325.	3258.	3192.	3128.	3065.	3004.	2945.	2881.	2814.
2745.	2680.	2608.	2462.	2235.	1833.	1350.	1058.	857.	721.
626.	557.	504.	462.	437.	417.	396.	374.	351.	329.
308.	288.	268.	250.	233.	217.	202.	188.	175.	163.
151.	141.	131.	122.	114.	106.	99.	92.	86.	80.
74.	69.	64.	60.	56.	52.	49.	45.	42.	39.
37.	34.	32.	30.	28.	26.	24.	23.	21.	20.
18.	17.	15.	15.	14.	13.	12.	11.	11.	10.
9.	9.	8.	7.	7.	6.	6.	6.	5.	5.
5.	4.	4.	4.	3.	3.	3.	3.	3.	2.
2.	2.	2.	2.	2.	2.	2.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
1.	1.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

STORAGE

99.	101.	103.	103.	104.	103.	103.	103.	102.	102.
102.	102.	104.	109.	123.	151.	234.	282.	396.	521.
635.	687.	715.	746.	773.	797.	816.	832.	843.	849.
851.	848.	844.	839.	833.	828.	822.	817.	812.	807.
802.	797.	792.	787.	782.	777.	773.	768.	764.	759.
755.	751.	745.	742.	738.	734.	730.	726.	723.	719.
715.	711.	708.	704.	701.	697.	694.	690.	687.	684.
681.	677.	674.	671.	668.	665.	662.	659.	656.	653.
650.	648.	645.	642.	639.	637.	634.	631.	629.	626.
623.	621.	618.	616.	613.	611.	608.	606.	603.	601.
598.	596.	593.	590.	588.	585.	583.	580.	577.	574.
570.	566.	552.	522.	478.	405.	330.	282.	252.	232.
219.	209.	202.	197.	192.	186.	181.	175.	169.	164.
159.	154.	149.	145.	141.	138.	134.	131.	129.	126.
124.	121.	119.	118.	116.	114.	113.	111.	110.	109.
108.	107.	106.	105.	105.	104.	103.	102.	102.	101.
101.	100.	100.	100.	99.	99.	99.	99.	98.	98.
97.	97.	97.	97.	97.	96.	96.	96.	96.	96.
96.	96.	95.	95.	95.	95.	95.	95.	95.	95.
95.	95.	95.	95.	95.	95.	95.	95.	95.	95.
95.	95.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.
94.	94.	94.	94.	94.	94.	94.	94.	94.	94.

STAGE

3.9	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
4.0	4.0	4.1	4.2	4.5	5.1	6.1	7.4	8.7	10.2
11.2	11.7	11.9	12.1	12.4	12.5	12.7	12.8	12.9	12.9
12.9	12.9	12.9	12.8	12.8	12.8	12.7	12.7	12.6	12.6
12.6	12.5	12.5	12.5	12.4	12.4	12.3	12.3	12.3	12.2
12.2	12.2	12.1	12.1	12.1	12.1	12.0	12.0	12.0	11.9
11.9	11.9	11.8	11.8	11.8	11.8	11.7	11.7	11.7	11.6
11.6	11.6	11.6	11.5	11.5	11.5	11.5	11.4	11.4	11.4
11.4	11.3	11.3	11.3	11.3	11.2	11.2	11.2	11.2	11.2
11.1	11.1	11.1	11.1	11.0	11.0	11.0	11.0	11.0	10.9
10.9	10.9	10.9	10.8	10.8	10.8	10.8	10.7	10.7	10.7
10.7	10.6	10.5	10.2	9.8	9.0	8.0	7.4	6.9	6.6
6.4	6.2	6.1	6.0	5.9	5.8	5.7	5.6	5.5	5.4
5.3	5.2	5.1	5.0	4.9	4.9	4.8	4.7	4.7	4.6
4.5	4.5	4.4	4.4	4.4	4.3	4.3	4.2	4.2	4.2
4.2	4.1	4.1	4.1	4.1	4.1	4.0	4.0	4.0	4.0
4.0	4.0	4.0	3.9	3.9	3.9	3.9	3.9	3.9	3.9
3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8

PEAK OUTFLOW IS 14064. AT TIME 31.00 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	14064.	13781.	12176.	8462.	704704.
CMS	398.	390.	345.	240.	19955.
INCHES		.89	3.15	6.56	7.59
MM		22.61	79.92	166.62	192.72
AC-FT		6834.	24151.	50354.	58240.
THOUS CU M		8429.	29790.	62111.	71838.

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

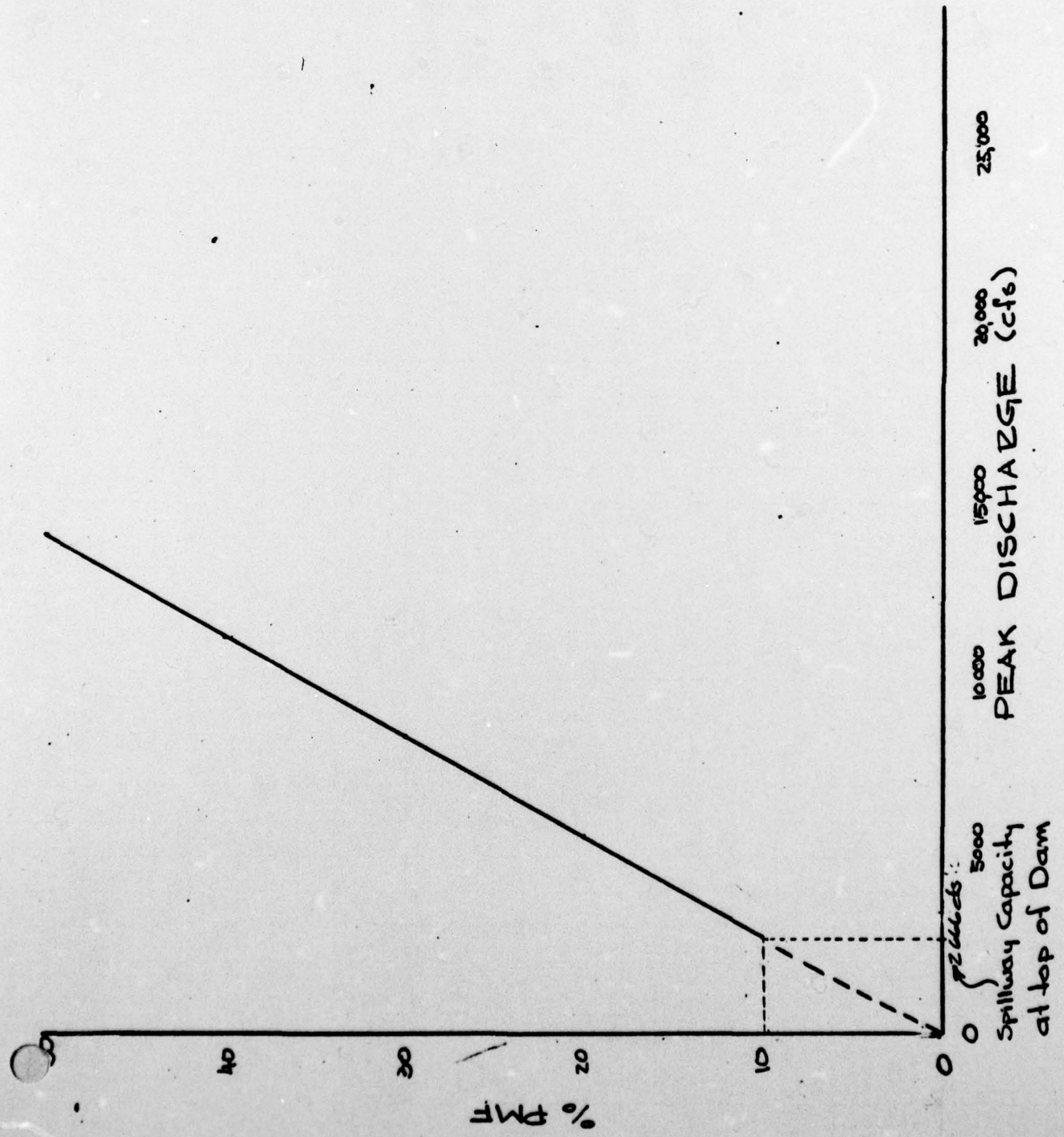
	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	3.80	3.80	10.60
STORAGE	94.	94.	564.
OUTFLOW	0.	0.	2666.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	12.92	2.32	851.	14064.	92.00	31.00	0.00
.40	12.50	1.90	793.	11251.	82.00	31.00	0.00
.30	12.03	1.43	731.	8438.	66.00	31.00	0.00
.20	11.48	.88	664.	5624.	45.00	31.00	0.00
.10	10.65	.05	570.	2746.	4.00	33.00	0.00

STORCH ENGINEERS Sheet ____ of ____

Project MILL DAM #1132 Made By EAW Date MAR 23, 1979

% PMF PASSED BY DAM Chkd By ____ Date ____



APPENDIX 5

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